BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXX. 1932

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.

ERRATA

Page 55, line 32, for *Merusliu* read *Merulius*.
" 303, line 13, delete *Per cent.* throughout.

Printed in Great Britain by
Hazell, Watson & Viney, Ltd., London and Aylesbury.

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VOL. XXX. 1932

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THE IMPERIAL INSTITUTE

South Kensington, S.W.7

GENERAL INFORMATION

THE Imperial Institute was founded as the Empire Memorial of the Jubilee of Queen Victoria. Its principal object is to promote the development of the commercial and industrial resources of the Empire.

Under the provisions of the Imperial Institute Act of 1925, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is President of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and certain other Government Departments, and of the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Director of the Institute is Lieut.-Gen. Sir William Furse, K.C.B., D.S.O.

The technical work of the Institute is carried out by two principal Departments, viz. a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is main-

tained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

Intelligence.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments, without charge.

Investigations.—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute in connection with the Ceylon Rubber Research Scheme.

Library.—The Library of the Institute contains a large collection of works of reference relating to the Empire Overseas and is regularly supplied with the more important reports and other publications of Government Departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 500 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available for the use of enquirers between the hours of 10 a.m. and 5 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

Statistical Section.—This section is concerned with the collection of statistics required in connection with the work of the Institute.

Publications.—The BULLETIN OF THE IMPERIAL INSTITUTE contains records of the principal investigations conducted for the Dominions, Colonies and India at the Imperial Institute, and articles and notes, chiefly relating to progress in tropical agriculture and forestry, the development of mineral resources, and the industrial utilisation of all classes of raw materials. A summary of research work conducted by Government Technical Departments overseas and a special bibliography of publications received in the library of the Imperial Institute are also included.

Other publications of the Institute include handbooks on "The Agricultural and Forest Products of British West Africa" and "Cotton and Other Vegetable Fibres"; Reports of the Indian Trade Enquiry; a Descriptive List of Some Empire Timbers; a Monograph on the Tanning Materials of the British Empire; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries.

Public Exhibition Galleries.—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, Colonies and India. It is the only exhibition of the kind in London where the countries of the Empire are represented under one roof.

A special feature has been made of pictorial representation, which takes the form of illuminated dioramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descriptive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation or preparation, and uses. To render the galleries of further assistance to teachers in the study of Empire geography and development, the exhibits are arranged in a definite sequence as suggested by the Advisory Education Committee of the Imperial Institute. Lectures

and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and other publications and picture postcards are on sale.

In the Exhibition Pavilion, attached to the Galleries, temporary exhibitions of special products are held.

The galleries are open free daily from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

Cinema.—The Empire Marketing Board maintains a Cinema Theatre in the Imperial Institute adjoining the Indian Section in the Exhibition Galleries. The Cinema is equipped with modern projectors, screen, lighting, heating and ventilating systems and has seating accommodation for 400 persons. The cost of this equipment was also borne by the Board. Films illustrating life and industries in the various countries of the Empire are shown daily at 10.15, 11.35, 2.15 and 3.35 (Sundays 2.45 and 4.15). Special arrangements are made for visits of organised parties from schools and educational institutions. Lectures on industries and countries of the Empire are frequently given in addition to the ordinary cinema displays.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

TRINIDAD WOODS AS PAPER-MAKING MATERIALS

DURING recent years the Forest Department, Trinidad, have carried out enumeration surveys over fairly extensive areas of forest in the island, and as a result have been able to obtain a reasonably accurate estimation of the composition of large areas of mixed forest. The work has shown that the species which occur in the greatest quantity are, unfortunately, those for which, so far, there is practically no market. The possibility of using the timber of these species for paper-making is being considered, and in September 1931, a supply of seven of the more abundant woods was forwarded by the Conservator of Forests to the Imperial Institute in order that paper-making trials might be carried out. The woods received were as follows:

1. Acurel (*Trichilia oblanceolata* Rusby): Natural Order Meliaceæ.
2. Hog Plum (*Spondias Mombin* Linn.): Natural Order Anacardiaceæ.
3. Yellow Mangue (*Symphonia globulifera* Linn.): Natural Order Guttiferæ.
4. Wild Chataigne (*Pachira insignis* DC.): Natural Order Bombacaceæ.
5. Jiggerwood (*Bravaisia floribunda* DC.): Natural Order Acanthaceæ.

6. Bois Mulatre (*Pentaclethra filamentosa* Benth.): Natural Order Leguminosæ.

7. Mahoe (*Sterculia caribæa* R. Br.): Natural Order Sterculiaceæ.

As an indication of the quantities of these woods that are available, the Conservator of Forests furnished the statement on this page showing their distribution over an area of 12,000 acres in the Central Range Reserve (Charuma).

The results of examination of the samples are given in the following pages. In all cases the chipped wood was submitted to treatment with caustic soda under conditions similar to those employed commercially for the production of paper-pulp by the soda process.

STOCK OF SPECIES ON 12,000 ACRES OF CENTRAL RANGE RESERVE (CHARUMA)

		Girth in feet.									
		1–2.	2–3.	3–4.	4–5.	5–6	6–7.	7–8.	8–9.	9–10.	Over 10.
Acurel	*Trichilia oblanceolata* . . .	12,330	8,370	3,870	3,780	1,620	90	180	—	—	—
Hog Plum	*Spondias Mombin* . . .	5,490	3,060	450	540	1,350	1,080	720	720	630	900
Yellow Mangue . . .	*Symphonia globulifera* . .	4,140	3,510	1,440	720	180	180	—	—	—	—
Wild Chataigne . . .	*Pachira insignis* . . .	22,500	16,470	8,640	10,260	7,560	2,430	1,800	450	540	630
Jiggerwood	*Bravaisia floribunda* . .	18,630	10,620	4,410	5,760	2,880	900	900	720	—	180
Bois Mulatre . . .	*Pentaclethra filamentosa* . .	138,690	98,550	35,550	19,260	2,160	180	—	—	—	—
Mahoe	*Sterculia caribæa* . . .	6,840	3,600	1,260	1,710	450	90	270	—	—	—

1. ACUREL WOOD (*TRICHILIA OBLANCEOLATA* RUSBY)

This consisted of a plank of hard, close-grained wood of pale pinkish-brown colour. The weight of the wood as received was approximately 51 lb. per cubic foot.

On chemical examination the wood gave the following results:

	Per cent.
Moisture	11·8
Ash	1·1
Cellulose, expressed on the wood as received	50·4
„ expressed on the moisture-free wood	57·1

The length and diameter of the ultimate fibres were as follows :

	Length. *mm.*	Diameter. *mm.*
Maximum	2·4	0·0254
Minimum	1·0	0·0076
Average	1·6	0·0163

The results of the paper-making trials expressed on the wood as received, were as follows :

		Trial A.	Trial B.
Parts of caustic soda employed per 100 parts of :			
Wood		20	20
Solution		4	4
Conditions of digestion :			
Time in hrs.		5	6
Temperature, °C.		160	160
Parts of caustic soda consumed per 100 parts of wood		13·1	13·3
Yield of air-dry pulp (containing 10 per cent. of moisture) :			
Unbleached	*per cent.*	51	49
Bleached	„	46	40
Yield of moisture-free pulp :			
Unbleached	„	46	44
Bleached	„	41	36

The conditions of Trial A were just sufficient to produce a well digested pulp which furnished a rather bulky, pale brown, fairly soft, opaque paper of good strength. The pulp did not bleach readily, but after bleaching it furnished a pale cream-coloured paper of similar character and strength to that from the unbleached pulp.

With a view to improving the colour of the bleached pulp a further digestion was carried out under the conditions of Trial B. The pulp thus obtained furnished a pale brown paper of similar strength and character to that of the unbleached paper produced in the first trial. It was found necessary to use a bleach solution of similar strength to that employed in Trial A, but the

bleached pulp in this case furnished an almost white paper of good strength and quality.

The examination of this Acurel wood has shown that it furnishes a good yield of pulp, which has excellent felting power, and produces paper of good strength. The pulp, however, does not bleach readily. In Trial A a larger amount of bleaching powder was required than is normally employed for bleaching soda pulps, and only a cream-coloured paper was obtained. The more drastic conditions of Trial B gave a 2 per cent. lower yield of pulp, which still required as much bleaching powder but furnished a satisfactory white paper of a type suitable for books.

2. Hog Plum Wood (*Spondias Mombin* L.)

This consisted of two planks of fairly soft, coarse-grained wood, of pale yellowish-brown colour. The wood had undergone partial decay, the planks being much discoloured and black patches occurring throughout. One end of each plank was particularly badly attacked, some of the wood being soft and rotten. The weight of the wood as received was approximately 30 lb. per cubic foot.

In taking a sample of the wood for examination it was not possible to eliminate the decayed portions, as they were distributed throughout the planks. On chemical examination the wood gave the following results:

	Per cent.
Moisture	10·6
Ash	1·0
Cellulose, expressed on the wood as received	50·6
,, expressed on the moisture-free wood	56·6

The length and diameter of the ultimate fibres were as follows:

	Length. *mm.*	Diameter. *mm.*
Maximum	2·0	0·0483
Minimum	0·7	0·0102
Average	1·5	0·0279

The results of the paper-making trials, expressed on the wood as received, were as follows:

	Trial A.	Trial B.
Parts of caustic soda employed per 100 parts of:		
Wood	20	20
Solution	4	4
Conditions of digestion:		
Time in hrs	5	6
Temperature, °C	160	160
Parts of caustic soda consumed per 100 parts of wood	14·7	15·0
Yield of air dry pulp (containing 10 per cent of moisture):		
Unbleached . . . . *per cent*	52	52
Bleached . . . . ,,	46	44
Yield of moisture-free pulp:		
Unbleached . . . . ,,	47	47
Bleached . . . . ,,	41	40

The conditions of Trial A were just sufficient to produce a well digested pulp which furnished a pale greyish-brown, tough, opaque paper, possessing good strength. The pulp did not bleach very readily, but the bleached pulp furnished a pale cream-coloured paper of similar strength and character to that from the unbleached pulp. Both papers showed a large quantity of small dark brown or black specks which were still conspicuous after the bleaching treatment.

With a view to the removal of the specks, a further digestion was carried out under the somewhat more drastic conditions of Trial B. The pulp produced in this digestion was, however, of similar character to that obtained in Trial A. It did not bleach more readily, and the pale cream-coloured paper obtained, which was of similar character and strength to that produced in Trial A, still contained a large number of specks, which would appear to have been derived from the decayed portion of the wood.

This Hog Plum wood gives a good yield of pulp, from which strong white paper, which would be suitable for book and printing purposes, can be obtained. The amount of bleaching powder needed to produce such paper is, however, larger than that normally employed for soda pulps. The quality of the pulp obtained in the present trials suffered seriously through the presence of numerous dark specks, apparently due to the wood being damaged through partial decay.

3. Yellow Mangue Wood (*Symphonia globulifera* L.)

This was a plank of hard, fairly close-grained wood, almost white to pale brown in colour. The weight of the wood as received was approximately 44 lb. per cubic foot.

On chemical examination the wood gave the following results:

	Per cent.
Moisture	10·6
Ash	0·5
Cellulose, expressed on the wood as received	53·4
„ expressed on the moisture-free wood	59·6

The length and diameter of the ultimate fibres were as follows:

	Length. *mm.*	Diameter. *mm*
Maximum	2·3	0·0305
Minimum	0·6	0·0127
Average	1·6	0·020

The following results, expressed on the wood as received, were obtained in the paper-making trials.

Parts of caustic soda employed per 100 parts of:		
Wood		20
Solution		4
Conditions of digestion:		
Time in hrs.		5
Temperature, °C.		160
Parts of caustic soda consumed per 100 parts of wood		12·2
Yield of air-dry pulp (containing 10 per cent of moisture):		
Unbleached	*per cent*	52
Bleached	„	47
Yield of moisture-free pulp:		
Unbleached	„	47
Bleached	„	42

The conditions of this trial were just sufficient to produce a well digested pulp which furnished a soft, opaque, bulky, brown paper, of fairly good strength. The pulp bleached fairly readily, and then furnished a pale cream-coloured paper of similar character and strength to that from the unbleached pulp.

The results of examination show that this Yellow Mangue wood gives a good yield of pulp, which bleaches

fairly readily and furnishes paper of satisfactory strength and quality, suitable for book and printing purposes.

4. Wild Chataigne Wood (*Pachira insignis* DC.)

This sample consisted of a plank of soft, coarse-grained, yellowish-white wood, much discoloured with patches of pale brown. The weight of the wood as received was approximately 25 lb. per cubic foot.

On chemical examination the wood gave the following results :

	Per cent.
Moisture	11·2
Ash	2·4
Cellulose, expressed on the wood as received	46·5
" expressed on the moisture-free wood	52·4

The length and diameter of the ultimate fibres were as follows :

	Length mm	Diameter. mm
Maximum	3·3	0·0508
Minimum	1·0	0·0127
Average	2·2	0·0251

The results of the paper-making trial, expressed on the wood as received, were as follows :

Parts of caustic soda employed per 100 parts of :		
Wood		20
Solution		4
Conditions of digestion :		
Time in hrs.		5
Temperature, °C		160
Parts of caustic soda consumed per 100 parts of wood		10·0
Yield of air dry pulp (containing 10 per cent. of moisture) :		
Unbleached	per cent.	46
Bleached	"	42
Yield of moisture-free pulp :		
Unbleached	"	41
Bleached	"	38

The conditions of this trial were just sufficient to produce a well digested pulp which furnished a tough, fairly bulky, opaque paper of good strength. The pulp bleached fairly readily, and then furnished an almost white paper of similar character and strength to that from the unbleached pulp.

The results of examination show that a fairly long-fibred pulp of very satisfactory quality is obtainable from Wild Chataigne wood, and that the pulp bleaches fairly readily and furnishes a strong paper of good quality, suitable for book and printing purposes.

5. JIGGERWOOD (*BRAVAISIA FLORIBUNDA* DC.)

This sample consisted of two planks of moderately hard, fairly close-grained wood, almost white except in the centre portions, which were reddish-brown. The weight of the wood as received was approximately 41 lb. per cubic foot.

On chemical examination the wood gave the following results:

	Per cent.
Moisture	11·6
Ash	4·2
Cellulose, expressed on the wood as received	51·1
,, expressed on the moisture-free wood	57·8

The length and diameter of the ultimate fibres were as follows:

	Length. *mm.*	Diameter. *mm.*
Maximum	2·2	0·0407
Minimum	0·7	0·0076
Average	1·4	0·0224

The following results, expressed on the wood as received, were obtained in the paper-making trial.

Parts of caustic soda employed per 100 parts of:		
Wood		20
Solution		4
Conditions of digestion:		
Time in hrs.		5
Temperature, °C.		160
Parts of caustic soda consumed per 100 parts of wood		9·5
Yield of air-dry pulp (containing 10 per cent. of moisture):		
Unbleached	*per cent.*	52
Bleached	,,	44
Yield of moisture-free pulp:		
Unbleached	,,	47
Bleached	,,	40

The conditions of this trial were just sufficient to produce a well digested pulp which furnished a pale

brown, opaque paper of good strength. The pulp bleached fairly readily and then furnished a white paper of similar character and strength to that from the unbleached pulp.

The results of examination show that Jiggerwood gives a good yield of pulp, which bleaches fairly readily although a rather high loss is sustained on bleaching. The paper obtained is of very satisfactory strength and quality, and suitable for book and printing purposes.

6. Bois Mulatre Wood (*Pentaclethra filamentosa* Benth.)

This sample consisted of a plank of hard, fairly close-grained wood of reddish-brown colour. The weight of the wood as received was approximately 41 lb. per cubic foot.

On chemical examination the wood gave the following results:

	Per cent.
Moisture	9·0
Ash	0·2
Cellulose, expressed on the wood as received	52·4
„ expressed on the moisture-free wood	57·6

The length and diameter of the ultimate fibres were as follows:

	Length. mm.	Diameter. mm.
Maximum	2·0	0·0356
Minimum	0·6	0·0102
Average	1·25	0·0217

The results of the paper-making trial, expressed on the wood as received, were as follows:

Parts of caustic soda employed per 100 parts of:		
Wood		20
Solution		4
Conditions of digestion:		
Time in hrs.		5
Temperature, °C.		160
Parts of caustic soda consumed per 100 parts of wood		11·3
Yield of air-dry pulp (containing 10 per cent. of moisture):		
Unbleached	per cent.	52
Bleached	„	47
Yield of moisture-free pulp:		
Unbleached	„	47
Bleached	„	42

The conditions of this trial were sufficient to produce a well digested pulp which furnished a pale brown, opaque paper of fairly good strength. The pulp did not bleach readily, and a fairly large amount of bleaching powder was necessary to produce a pale cream-coloured paper, which was of similar character and strength to the unbleached paper.

The results of examination have shown that Bois Mulatre wood is capable of giving a good yield of pulp, which is somewhat difficult to bleach but furnishes paper of fairly good strength, suitable for book and printing purposes.

7. Mahoe Wood (*Sterculia caribæa* R.Br.)

This sample consisted of two planks of rather soft, coarse-grained, almost white wood. The weight of the wood as received was approximately 32 lb. per cubic foot.

On chemical examination the wood gave the following results:

	Per cent.
Moisture	10·7
Ash	1·4
Cellulose, expressed on the wood as received	54·3
„ expressed on the moisture-free wood	60·8

The length and diameter of the ultimate fibres were as follows:

	Length. *mm.*	Diameter. *mm.*
Maximum	3·0	0·0381
Minimum	1·0	0·0127
Average	2·1	0·0236

The following results, expressed on the wood as received, were obtained in the paper-making trial:

Parts of caustic soda employed per 100 parts of:		
Wood		20
Solution		4
Conditions of digestion:		
Time in hrs.		5
Temperature, °C.		160
Parts of caustic soda consumed per 100 parts of wood		9·7
Yield of air-dry pulp (containing 10 per cent. of moisture):		
Unbleached	*per cent.*	57
Bleached	„	51
Yield of moisture-free pulp:		
Unbleached	„	51
Bleached	„	46

The conditions of this trial were sufficient to yield a well reduced pulp which furnished an opaque, pale brown paper, of good strength, but showing numerous undisintegrated fibrous particles. The pulp bleached fairly readily, and furnished an almost white paper of similar strength and character to that from the unbleached pulp and free from the fibrous particles, which had yielded to the bleaching treatment.

The examination of this Mahoe wood has furnished very promising results, showing that the material gives a satisfactory yield of fairly long-fibred pulp, which has good felting power, and bleaches fairly readily. The paper is of good strength and would be suitable for book and printing purposes.

Summary and Conclusions

The following table shows the amounts of caustic soda consumed in the pulping trials with the seven woods, and the yields of pulp obtained. The latter figures are reduced to a moisture-free basis so as to be strictly comparable.

Wood.	Trial	Parts of caustic soda consumed per 100 parts of moisture free wood	Yields of moisture-free pulp, expressed as percentages of the moisture-free wood.	
			Unbleached.	*Bleached.*
1. Acurel	A	14·0	52	47
	B	15·1	50	41
2. Hog Plum	A	16·4	52	46
	B	16·8	52	45
3. Yellow Mangue	-	13·6	53	47
4. Wild Chataigne		11·3	46	43
5. Jiggerwood		10·7	53	45
6. Bois Mulatre		12·4	52	46
7. Mahoe		10·0	57	52

These figures show that the best yield of pulp was obtained from the Mahoe wood (*Sterculia caribæa*), but good yields were given by most of the other samples.

Apart from specks which occurred in the paper from No. 2, the papers produced from Nos. 1, 2, 5 and 6 were similar in character, and resembled those obtained from some commercial soda wood pulps; the pulps from Nos. 1, 2 and 6 were, however, difficult to bleach. The paper made from No. 3 differed from that obtained from any

of the other samples in being appreciably softer and not so strong, though the pulp from this wood bleaches the most readily of the whole series.

Nos. 4 and 7 yielded the longest-fibred pulps, and produced rather better papers than any of the other samples, but the yield of bleached pulp from No. 4 was somewhat low. The amounts of caustic soda consumed in the treatment of these two woods were appreciably lower than in the case of the other samples with the exception of No. 5. The Mahoe wood (No. 7) gave the best results in respect of the high yield of pulp and the good quality of the paper.

The fibres in the pulp prepared from the seven woods had a rather higher average length in each case than those of pulp made from aspen, which is the "hardwood" most commonly employed in the manufacture of soda pulp.

GUMS FROM NIGERIA

THE five samples of gum which are the subject of this report were submitted by the Director of Forests in August 1931.

The following particulars were furnished regarding the origin and identity of the samples :

No. 1. "*Kolkol*" (*Acacia Verek* = *A. Senegal*). Cleaned from tapped trees.

No. 2. "*Kolkol*" (*Acacia Verek* = *A. Senegal*). Natural exudations from untapped trees.

No. 3. "*Chiriri*" (*Combretum leucanthum*).

No. 4. "*Marike*" (*Anogeissus Schimperi*).

No. 5. "*Farakaya*" (*Acacia Sieberiana*).

It was stated that samples Nos. 1 and 2 were collected in the Bornu Province and Nos. 3, 4 and 5 in the Sokoto Province. Nos. 3, 4 and 5 had been received from a commercial company operating in Nigeria, and the Director of Forests was not able to guarantee their botanical identity.

Description

No. 1. "*Kolkol.*" *From tapped trees.*—Small and large tears varying from almost colourless to pale reddish-brown, but generally of the latter tint. Externally the tears were slightly weathered.

No. 2. "*Kolkol.*" *Natural exudations from untapped trees.*—Small and large tears and fragments, varying from almost colourless to pale reddish-brown; on the whole pale pinkish-brown. Externally the tears were slightly weathered.

No. 3. "*Chiriri.*"—Small and large tears, conglomerates and fragments, varying in colour from pale pinkish-brown to reddish-brown, but on the whole dark-coloured. Externally the surface was in some cases slightly weathered, and in others glassy.

No. 4. "*Marike.*"—Small and large tears and fragments, varying in colour from pale straw-yellow to pale brown; on the whole pale brown. Externally the surface was in some cases slightly weathered, and in others glassy.

No. 5. "*Farakaya.*"—Small and large tears, conglomerates and fragments, varying in colour from pale straw-yellow to pale reddish-brown, but on the whole brown. Externally the surface was in some cases slightly weathered, and in others glassy.

All the five samples were clean, very little "dirt" being present. The fracture in each case was vitreous.

Results of Examination

The samples were examined, with the following results:

	No. 1 Kolkol.	No. 2 Kolkol.	No. 3 Chiriri.	No. 4. Marike.	No. 5. Farakaya.
Moisture . . *per cent.*	17·7	14·8	15·4	14·8	14·9
Ash . . . . *per cent.*	3·3	3·3	1·6	1·8	1·9
Viscosity (at 20° C.) of a 10 per cent solution	12·4	9·5	16·9	12·5	11·5
Matter insoluble in water *per cent.*	0·3	0·2	2·1	0·7	0·9
Acid value	3·4	2·9	9·4	8·0	6·5

All five gums possessed good adhesive properties.

For purposes of comparison, the following results of the examination of previous samples of three of the present

varieties of gums from Nigeria may be quoted from this BULLETIN (1910, **8**, 352 ; 1914, **12**, 27) :

		Kolkol (6 samples).	Chiriri (1 sample).	Acacia Sieberiana (4 samples).
Moisture	*per cent.*	10·24–13·5	12·9	10·2–13·03
Ash	*per cent.*	2·87–3·5	2·0	2·1–2·9
Viscosity (at 22° C.) of a 10 per cent. solution		5·36–6·66	7·8	4·7–13·3
Matter insoluble in water	*per cent.*	0·1–1·94	1·2	0·76–3·1
Acid value		3·2–3·3 [1]	—	3·9–4·4 [2]

[1] *Three samples only.* [2] *Two samples only.*

The two sets of samples thus gave similar results except in the case of the viscosity, for which property, even after allowing for the difference in temperature, the present samples of Kolkol and Chiriri gums gave much higher figures.

All the present samples are gums of the soluble type and are in good clean condition. In order of colour they can be placed as follows : Nos. 2, 4, 1, 5 and 3 (the last two being rather dark from a market point of view). All the samples possess satisfactory viscosities when tested in a 10 per cent. solution, but the acid values of Nos. 3, 4 and 5 are higher than desirable. The amounts of ash and insoluble matter are satisfactorily low.

A comparison of Kolkol No. 1 from tapped trees with Kolkol No. 2 from untapped trees showed that the former was not of such good colour as No. 2, being of a more reddish tint. Its viscosity, however, is slightly higher than that of No. 2.

Commercial Value

The gums were submitted to a firm of importers in London, who furnished the following report :

" *No.* 1. *Kolkol* (*from tapped trees*).—Not so useful as sample No. 2 (see below) on account of its reddish colour, but nevertheless saleable at about 29*s*. per cwt. c.i.f. United Kingdom ports.

" *No.* 2. *Kolkol* (*natural*).—Very saleable quality, similar to Kordofan cleaned, except that the viscosity is

not so good. Present value would be from 31*s*. to 32*s*. per cwt. c.i.f. United Kingdom ports.

" *No.* 3. *Chiriri.*—Very difficult to sell. The market is glutted with similar grades, which are offering at 7*s*. 6*d*. to 9*s*. per cwt., according to quality, but there are no buyers.

" *No.* 4. *Marike.*—We value this at 18*s*. to 20*s*. per cwt. c.i.f. It is difficult to dissolve, and would not meet with a very large demand unless there was a shortage of Kordofan and Senegal gums. Among certain buyers, limited quantities could be disposed of, if the price offered sufficient inducement, but we place 20*s*. as the absolute maximum under present-day values and conditions.

" *No.* 5. *Farakaya.*—We place this in the same category as Sample No. 3, except that the quality is a shade better, and worth about 1*s*. per cwt. more.

" Regarding Sample No. 4, we think this would meet with a moderate demand, provided the grade was not inferior to type, but it is on the borderline and the slightest deviation of the type would relegate this grade into categories 3 and 5.

" To sum up the general position, Niger gums must necessarily follow the values of Kordofan and Senegal gums, which to-day stand at a very low level. Niger gums are at a disadvantage inasmuch as the qualities of Kordofan and Senegal gums are standardised, whereas the qualities of Niger gums vary considerably and no definite standards have been fixed.

" Samples 1 and 2 can be sold in considerable quantities on c.i.f. terms, provided the out-turn can be guaranteed equal to the type samples.

" We ourselves could take up to 1,000 tons of these gums per annum. We should discourage the export of the lower grades, i.e. 3 and 5, as they are difficult to sell and the present low values cannot cover the cost of picking and transportation."

In connection with the above report it may be mentioned that the following prices per cwt. were quoted in London for gum arabic: Kordofan natural, 43*s*.; Kordofan cleaned, 45*s*. (November 1931).

SISAL HEMP FROM THE BAHAMAS AND SIERRA LEONE

The following samples of Sisal hemp have recently been examined at the Imperial Institute.

I. Bahamas

A sample of fibre that had been cleaned by the improved Chipman Sisal decorticator, was forwarded by the Acting Colonial Secretary in August 1931, in order that its tensile strength might be determined.

The sample consisted of clean, lustrous, well-prepared fibre, varying from pale cream to cream in colour. The fibre was of fairly regular length, varying from 3 ft. 6 in. to 4 ft. 6 in. and being mostly about 3 ft. 9 in. to 4 ft.

The breaking loads of single strands of the fibre were determined by means of the Schopper testing machine. An endeavour was made to select for this purpose strands of as nearly as possible the same cross-sectional area. Twenty such strands were selected and each was tested at three points, viz. near the butt end, in the middle and near the tip.

The breaking load obtained as the average of the sixty tests was 1,572 grams, as compared with 1,478 grams obtained with a previous sample prepared by the Chipman machine and forwarded to the Colonial Office by the Bahamas Government in July 1930.

Similar tests carried out with a commercial sample of East African Sisal of No. 1 grade gave an average breaking load of 1,418 grams. In all three cases the fibres tested were of approximately the same cross-sectional area.

The results are compared in the following table :

—	Bahamas Sisal prepared by the Chipman machine.		Commercial No 1 East African Sisal.
	Present sample	Previous sample	
	Grams.	*Grams*	*Grams.*
Maximum breaking load .	2,450	2,325	2,500
Minimum breaking load .	425	550	350
Maximum variation .	2,025	1,775	2,150
Average breaking load .	1,572	1,478	1,418

It is obvious from the nature of Sisal hemp and the wide range of figures obtained in the tests, that the *average* results can be regarded as only roughly approximate. They indicate, however, that the present sample is of satisfactory strength, comparing favourably with that of commercial East African Sisal.

II. Sierra Leone

A sample of fibre, grown and prepared at the Njala Agricultural Station, was forwarded by the Director of Agriculture, in June 1931.

The sample consisted of clean, well-prepared, rather lustrous, pale-cream coloured fibre, from 5 ft. to 5 ft. 3 in. in length and possessing good strength.

A representative portion of the sample was submitted to chemical examination, with the following results, which are given in comparison with figures obtained at the Imperial Institute for a previous sample of Sisal hemp grown at Njala and also with the range of figures for a series of East African Sisal hemps recently examined :

		Sisal from Njala.		East African Sisal.	
		Present sample	Previous sample	No 1 Brushed.	No 2 Brushed.
		Per cent	*Per cent.*	*Per cent.*	*Per cent.*
	Moisture . . .	11·8	8·9	9·3– 9·9	9·4–10·1
Expressed on the moisture-free material	Ash . . .	0·6	0·6	0·5– 1·2	0·9– 1·3
	α-Hydrolysis, loss	10·8	10·3	10·2–11·6	10·2–11·6
	β-Hydrolysis, loss .	12·8	12·7	12·3–14·4	13·4–14·0
	Water washing, loss .	1·2	0·5	1·0– 2·4	1·3– 2·8
	Cellulose . . .	77·0	77·6	77·0–79·8	76·3–79·1

The above results show that the present sample of fibre from Njala is of good quality, and similar in composition and behaviour to good commercial samples of East African Sisal.

The sample was submitted for valuation to a firm of fibre merchants (Messrs. Wigglesworth & Co., Ltd.), who furnished the following report, dated July 31, 1931 :

" Over 4 ft. long ; bold fibre of less strength than East African. Decortication satisfactory ; colour and

quality equivalent to East African Sisal, but the thin end is rather inclined to twist and is discoloured at the point of the fibre through too long exposure before decortication.

"With East African Sisal valued to-day at £15 10s. per ton for No. 1, we should place a value of £15 per ton on this sample.

"It may be stated that the present selling price is far below the cost, and is due to exceptional circumstances in regard to the world-wide financial crisis.

"Technically there is no fault to find with this fibre, although the butt end is rather coarser than in Tanganyika."

This sample of Sisal hemp from Njala is generally well cleaned and prepared, and is very satisfactory in length. Its strength, however, although good, is not quite equal to that of well-prepared East African Sisal.

The present sample was of better strength, colour and preparation than the sample of Sisal from Njala which was examined at the Imperial Institute in 1919.

SOILS FROM THE SEYCHELLES

Few analyses appear to have been recorded of the soils of the Seychelles, and the following report, which includes what are probably the first fairly complete analyses of the soils of the Praslin group, originating from granitic rocks in the island, may be of interest.

The decomposition of other rocks, such as diorites, etc., has produced uncultivable clayey soils, which are, in some cases, said to be suitable for ceramic purposes.

The four samples which form the subject of the report were received from the Director of Agriculture, Seychelles, in co-operation with the Imperial Bureau of Soil Science. They were stated to have been collected on Félicité Island, one of the last islands of the Praslin group of the Seychelles to have been brought under cultivation, a large portion of the island having still been under forest in the year

1900. Practically the whole plantable area of Félicité Island is occupied by coconut palms.

The descriptions of the soils, with information regarding the locality, cultivation and type, are as follows :

No. 1.—A heavy clay soil, of a yellowish colour. This is a worn-out piece of land, on which coconut palms did not grow well. It is really the subsoil which has emerged on the surface by erosion, but is a soil of a type of common occurrence in old plantations in the locality.

No. 2.—A coarse gravelly type of soil. This is a better type of soil taken at Grand' Anse from the hillsides where coconut palms are growing luxuriantly. It is very porous and represents the surface soil of the island after fifty years' cultivation.

No. 3.—A sandy and gravelly soil of very coarse texture. This is a forest soil brought under cultivation three years ago, and is somewhat washed out by erosion.

No. 4.—A clay soil, of a marked yellowish colour. This is a red soil originating from a dyke of basalt which is decomposed to a depth of several feet between two lips of coarse granite. Although it occurs only in small isolated areas, it has been found to be very suitable for growing coffee.

Results of Examination

The samples were submitted to mechanical and partial chemical analyses, with the results shown in the following tables.

As the depth of sampling was not stated, this has been assumed to have been 9 inches in all cases.

PRELIMINARY MECHANICAL ANALYSIS ON THE ENTIRE SOIL, WHICH WAS AIR-DRIED BEFORE EXAMINATION

(Results in percentages)

—	Size of particles in mm.	No. 1.	No. 2.	No. 3.	No. 4.
Stones and gravel	Over 2·0	1·6	43·2	63·6	7·9
"Fine earth"	2·0 and under	98·4	56·8	36·4	92·1

MECHANICAL ANALYSIS OF "FINE EARTH"

(Results in percentages)

—	Size of particles in mm	No. 1.	No. 2.	No. 3.	No. 4.
Coarse sand [1]	2·0 to 0·2	10·7	55·7	63·9	27·0
Fine sand [1]	0·2 to 0·02	9·8	12·9	10·9	8·2
Silt [1]	0·02 to 0·002	15·7	11·0	7·1	8·7
Clay [1]	0·002 and under	50·2	18·2	14·3	52·0
Moisture at 105° C.		8·36	1·51	2·13	3·42
Matter soluble in water		0·25	0·12	0·11	0·13
Calcium carbonate		0·09	0·05	0·18	0·45
Loss on ignition (not including moisture at 105° C. or CO_2 from carbonates)		13·48	4·22	6·59	11·69
Reaction of soil		Acid	Faintly acid	Faintly acid	Acid
pH value (indicator method)		5·2	6·5	6·3	5·3

[1] *Fractions dried at 105° C.*

CHEMICAL ANALYSIS OF "FINE EARTH"

SOLUBLE IN HYDROCHLORIC ACID

—		No. 1.	No. 2.	No. 3.	No. 4.
		Per cent.	*Per cent.*	*Per cent*	*Per cent*
Phosphoric acid	P_2O_5	3·457	0·138	0·135	0·223

AVAILABLE PORTION, *i.e.* PORTION SOLUBLE IN 1 PER CENT. CITRIC ACID SOLUTION

—		No. 1	No. 2.	No. 3.	No. 4.
		Per cent.	*Per cent*	*Per cent.*	*Per cent.*
Phosphoric acid	P_2O_5	1·44	0·0142	0·0110	0·0114
		lb per acre	*lb per acre*	*lb per acre*	*lb per acre.*
Phosphoric acid	P_2O_5	32,599	362	296	258

EXCHANGEABLE BASES (HISSINK METHOD)

—		No. 1.	No. 2.	No. 3.	No. 4.
		Per cent	*Per cent*	*Per cent.*	*Per cent.*
Lime	CaO	0·122	0·108	0·175	0·037
Magnesia	MgO	0·035	0·039	0·061	0·026
Potash	K_2O	0·061	0·026	0·011	0·026

OTHER CONSTITUENTS DETERMINED

—	No 1.	No. 2.	No. 3.	No 4.
	Per cent.	*Per cent*	*Per cent.*	*Per cent.*
Nitrogen (total) . N	0·19	0·091	0·22	0·063
Organic carbon (total) C	3·01	0·97	2·79	0·93
Organic matter [1] (total)	5 47	1·76	5·07	1·69
Carbon dioxide (total) CO_2	0 04	0·02	0·08	0·20
	lb per acre	*lb per acre.*	*lb. per acre*	*lb per acre.*
Nitrogen (total) . N	4,301	2,320	5,923	1,426
Organic carbon (total) C	68,140	24,729	75,110	21,053

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

The figures for lb per acre of the various constituents in the above tables are calculated for a depth of 9 inches of soil, the apparent specific gravity of the soil being taken into consideration.

	No 1.	No. 2.	No 3.	No. 4.
Atomic ratio, $\frac{\text{Carbon, C}}{\text{Nitrogen, N}}$ . .	18·5	12·4	14·8	17·2

Remarks

Sample No. 1.- This soil is of a heavy character, containing 50 per cent. of clay. Soluble salts are present in large amount for a soil and consist mainly of chlorides, only a trace of sulphates being present. The reaction of the soil is strongly acid.

As regards chemical composition, the amount of exchangeable lime is not very high, but it is considerably in excess of the magnesia. The quantity of exchangeable potash in this sample is large, even for a heavy clay soil, and is much the highest amount found in this series of soils. The percentage of nitrogen is fairly high, and there is a large amount of organic matter, the ratio of carbon to nitrogen being much above the normal. The soil also gave indications that the organic matter present is not of a normal type.

The most striking feature in the composition of this soil is the quantity of phosphoric acid, in both the acid soluble and the available forms. The amount of this constituent is abnormally high, and as there are stated to be many rocky islets in the neighbourhood of Félicité Island where guano deposits are still being formed, it suggests that this sample is scarcely a true soil, but must include a large proportion of guano. This assumption is supported by the readily soluble character of some of the

organic matter present and by the presence of much larger quantities of soluble salts, particularly chlorides, than are usually found in normal soils. The presence of a certain amount of chlorides would be explained by proximity to the sea, but this fact would not account for the larger amount of soluble salts in this soil as compared with Nos. 2, 3 and 4.

From a chemical standpoint, it does not appear possible to describe this soil, if it is typical of a large area, as "worn out." All the essential plant food constituents appear to be available in adequate or even large quantities. The physical composition of the soil shows that it is of a heavy type, and its poorness may therefore be due to its physical characteristics. Coconut palms appear to be able to grow on practically any type of soil, but they usually do best on a fairly light soil where there is a constant supply of fresh underground water. The present soil would probably not be sufficiently porous to maintain an adequate supply of water to the roots of coconut palms.

Sample No. 2.—This soil, which is of quite a different type from No. 1, contains large proportions of gravel and of coarse sand, so that it would probably be very readily drained. Soluble salts are rather high in amount and consist mainly of chlorides, possibly of marine origin.

In chemical composition, the amount of exchangeable lime is satisfactory for a porous type of soil and is considerably in excess of that of the magnesia. The amount of exchangeable potash is fairly high and should prove sufficient for crop growth. The quantities of phosphoric acid, both acid soluble and available, although not high, are probably adequate for crop growth. The percentage of nitrogen is fairly satisfactory, and although the amount of organic matter present is somewhat low, the ratio of carbon to nitrogen is normal.

Sample No. 3.—This soil is rather similar to No. 2, but is of an even coarser type, the quantities of both gravel and coarse sand being very high. The amount of soluble salts present approximates to that found in No. 2, and again the salts consist mainly of chlorides, only a small quantity of sulphates being present. The reaction of the soil is faintly acid.

As regards chemical composition, this soil resembles No. 2, especially with respect to the percentages of phosphoric acid present. The amounts of exchangeable lime and magnesia are, however, higher than in No. 2, and should be adequate for a light type of soil, but the quantity of exchangeable potash is somewhat low, being considerably less than that found in No. 2. The percentages of nitrogen and of organic matter are high, as would be expected in a forest soil which has been under cultivation for only three years. The ratio of carbon to nitrogen is slightly above the normal.

Sample No. 4.—This soil is of a heavy clay type, somewhat resembling No. 1 in mechanical composition, although the coarse sand is considerably higher in amount in this sample. Soluble salts are also rather high in amount, about the same quantity being present as in Nos. 2 and 3, and they again consist mainly of chlorides. Although there is a small amount of calcium carbonate present, the reaction of the soil is decidedly acid. A noteworthy feature of this soil was its tendency to settle rapidly when mixed with a large quantity of water.

In chemical composition, this soil is on the whole rather lacking in plant food constituents. The amounts of exchangeable lime and magnesia, especially the former, are low. The quantity of exchangeable potash is fairly high, as would be expected in a heavy clay soil, and the percentage of available phosphoric acid is probably adequate, although it is not high, and the reserve in the acid soluble form is rather small. The percentages of nitrogen and of organic matter are low, and the ratio of carbon to nitrogen is much higher than the normal.

Summary and Conclusions

These four soils are of widely varying types, although Nos. 1 and 4 both contain a large proportion of clay, and Nos. 2 and 3 are somewhat similar in their mechanical composition.

Chemically, the soils differ very considerably, No. 1 having by far the largest proportions of the essential plant food constituents, while No. 4 is the worst in this respect.

Nos. 2 and 3 appear to be fairly well supplied for the present.

The only manurial treatment which appears to be called for would be the application of lime to No. 4, this being the constituent most likely to be deficient. No. 3 contains rather small amounts of potash, additions of which may be required in the near future. If the sample No. 1 received is typical of any considerable area, this should not need any manurial additions for a long period, although its physical condition is probably poor.

On the whole, these samples appear to indicate that the parts of the island from which they were taken should be fertile and suitable for growing most of the local crops. Terracing to check erosion, in the case of No. 1, and improvement of physical condition of Nos. 1 and 4 by careful cultivation, would probably be very useful.

ARTICLES

THE EXPERIMENTAL CULTIVATION OF TUNG TREES IN THE EMPIRE

THE Chinese wood oil of commerce is derived from two trees, *Aleurites Fordii* Hemsl. and *A. montana* E. H. Wilson. The former occurs abundantly in the warm temperate parts of central and western China, especially in the Yangtze valley, and yields tung oil, while the latter is found in southern China and requires a more tropical climate and a heavier hot-weather rainfall. The oil from *A. montana* is known in China as " Mu-yu " and is stated to possess similar properties to those of tung oil.

Chinese wood oil was introduced commercially into western Europe over thirty years ago and to-day is an essential raw material of paint and varnish manufacture. It possesses unique drying properties which render it indispensable for certain types of varnish in which tough, water-resistant films of high gloss are desired. The oil is also widely used in the manufacture of electrical insulating varnishes.

At the present time the only source of commercial supplies of the oil is China, from which over 69,000 tons were exported in 1930. The principal market for the oil is in the United States of America, where increasing quantities are being used every year, some 56,000 tons having been imported in 1930. In comparison, only small quantities are imported into the United Kingdom, the figure for 1930 being about 4,000 tons. The use of Chinese wood oil in the latter country is, however, becoming more general, while other European countries also are beginning to display an interest in the oil and increasing amounts will doubtless find a market in these countries.

It is estimated that about 90 per cent. of the oil exported from China is derived from tung trees (*A. Fordii*), while the remaining 10 per cent. is obtained from *A. montana.* The oils are sometimes indiscriminately mixed.

In view of the importance of Chinese wood oil to the paint and varnish manufacturers, the need has been felt of freeing this industry from its sole dependence on China for supplies. Accordingly attempts have been made to grow the trees in other countries of the world. In the United States of America the cultivation of *Aleurites Fordii* on a commercial scale has been started within the last ten years in certain southern States, and the acreage under the crop is being continually increased. For example, in Florida the area was 2,500 acres in 1926, 4,000 in 1928, and 5,000 by the end of 1929. In Georgia 2,000 acres had been planted up to 1930 and it was proposed to add another 3,000 acres in the autumn of 1931. In the first half of that year (1931), 4,000 acres were planted in Mississippi and 2,000 in northern Florida. A few of these plantations are now in bearing. On one estate of 30 acres, six-year-old trees have given a yield of approximately 1,300 lb. of fruits per acre, equivalent to about 280 lb. of oil per acre. On the whole, the yields of fruit obtained in America have not come up to expectations. This may be due to the fact that late spring frosts are liable to occur when the trees are in blossom in those States where plantations have been established, with the result that the yield of fruit has been adversely affected.

It is possible that in countries where the danger of frosts does not occur, higher yields will be obtained.

As regards the British Empire, the Imperial Institute as long ago as 1917 initiated experiments in the cultivation of both species of trees in India and a number of the Colonies. The results of these trials were on the whole inconclusive. In Kenya, however, two of the *A. Fordii* trees fruited and a sample of the produce was examined at the Imperial Institute, when it was found that the seeds contained a normal percentage of oil of the usual character (see this BULLETIN, 1929, **27**, 10).

The question of the cultivation of tung trees in the Empire was again taken up in 1927 by the Imperial Institute Advisory Committee on Oils and Oilseeds and this Committee, in collaboration with the Director of the Royal Botanic Gardens, Kew, and the Director of the Research Association of British Paint, Colour and Varnish Manufacturers, distributed supplies of seed obtained from China and Florida to various countries of the Empire.

In view of the importance of producing tung oil in the Empire, the question was considered by an inter-departmental conference convened by the Department of Scientific and Industrial Research in March 1929 and on their recommendation a special Sub-Committee was appointed by the Advisory Committee on Oils and Oilseeds to deal with this problem. Besides continuing the encouragement of the experimental cultivation of tung trees within the Empire by the distribution of seed and the dissemination of related information, the Sub-Committee have arranged for the investigation at the Paint Research Station of cognate problems, the elucidation of which will contribute to the success of this Imperial production. Among the investigations that have been commenced are a comparison of the chemical and physical properties of the oils of *A. Fordii* and *A. montana* and the determination of the value as a feeding-stuff for animals of the cake or meal left after the removal of the oil from the seeds. In addition, a memorandum entitled "The Production of Tung Oil in the Empire" was prepared at the Imperial Institute with the co-operation of the Sub-Committee and issued by the Empire Marketing Board, who, besides

undertaking the publication of this pamphlet, have provided the necessary funds for the investigations.

During the last four years nearly 4 tons of *A. Fordii* seed and about 700 lb. of *A. montana* seed have been distributed by the Royal Botanic Gardens, Kew, in co-operation with the Sub-Committee, mainly for experimental trial in those parts of the Empire where climatic conditions were considered suitable for the cultivation of the crop. Among the countries where trials are now in progress are the following: Australia, New Zealand, New Guinea, Fiji, India, Ceylon, British Malaya, Seychelles, Mauritius, Union of South Africa, Kenya, Tanganyika, Nyasaland, Rhodesia, Sudan, Nigeria, Sierra Leone, St. Helena, Cyprus, Palestine, Iraq, British Honduras, Bermuda, Leeward Islands, Jamaica and other West Indian islands. In some of these countries cultivation experiments have also been started independently of the Sub-Committee.

Up to the present time much more attention has been given to the experimental cultivation of *A. Fordii* than of *A. montana*. The reasons for this are that, as already stated, the former species furnishes about 90 per cent. of the Chinese wood oil of commerce and also because, prior to the recent developments, practically the whole of the experience in the cultivation of the trees was that gained in the United States of America, where *A. Fordii* is being grown. In many cases the trials with *A. Fordii* have not been in progress sufficiently long for the trees to have had time to fruit, while in those where fruit has been produced the experiments will have to be continued before any conclusion can be drawn as to likely yields.

At the same time as trials have been made with *A. Fordii*, the experimental cultivation of the allied species, *A. montana*, has been carried on. In the main these tests have been failures, as the seed, which has to be obtained from China, appears to lose its viability very readily, with the result that very little germination, if any, has taken place after the seed has been sown.

In view of the great interest which is being displayed in the production of tung oil, a brief summary of the experiments so far carried out with both species of *Aleurites* is given below. It must be understood that the

trials in Empire countries are still in the experimental stage and that in no case has it yet been established that the cultivation of the trees on a commercial scale will prove remunerative.

India.—The principal trials in this country are being conducted in Burma and Assam.

Near Taunggyi, Southern Shan States, at an elevation of 4,650 ft., the Department of Agriculture in 1929 established plantations of *A. Fordii* totalling about 30 acres and containing some 2,100 plants. These plants were in a healthy condition in October 1930 and showed every sign of successful development with the exception of a small area transplanted too late in October of the previous year. Although good results are anticipated, it is not expected that they will be equal to those obtained in the plantation of Tung Oil Estates Ltd. at Hsum Hsai, Northern Shan States, as the elevation at Taunggyi of 4,650 ft. is possibly rather high and tung trees grow better on a well-drained, porous soil, which is more in evidence in the Northern than the Southern Shan States. The Tung Oil Estates Ltd. commenced operations during the latter half of 1930. By the end of 1931, some 720 acres had been cleared and planted, the nurseries and seed at stake both looking exceptionally well. From a small batch of seed planted in 1929 in the same area, the plants are now over 6 ft. in height and look very healthy. It is hoped to receive the first sample of nuts from the 1929 plants during the current year. A further 750 acres are being cleared and planted up this year. Both *Aleurites Fordii* and *A. montana* are growing on the estate, but it is too early at present to give any opinion as to their comparative suitability.

The Department of Agriculture, Burma, have also made experiments at Maymyo, Mandalay, and at Hmawbi Agricultural Station. At the former place germination of the seed of *A. Fordii* was good, and although the plants made little growth in the first year, they did well in the following year, reaching an average height of about 4 ft. A number of two-year-old plants were subsequently transplanted with very few casualties. Good germination was also obtained at Hmawbi and growth was so vigorous

that 3 months-old seedlings were removed from the nursery and transplanted. They made satisfactory, but rather uneven, growth and twelve months after being transplanted were robust and had an average height of 4 ft., the tallest being 7 ft. Some of the same lot of seedlings were transplanted when 14 months old but, although healthy, have not made such rapid growth as those planted out at an earlier age. Only 84 plants of *A. Fordii* at present are established at Hmawbi.

In Assam, *A. Fordii* trees are making good growth and fruiting in some cases when only 18 months old. A number of tea estates have made experimental plantings, but no particulars of the acreage planted have been received. Some of these tea estates which were supplied with seed in 1928 are now using their own seed for sowing.

At Naojan, Mr. D. S. Withers on his estate of 1,200 acres had in July 1930 approximately 35,000 seedlings of *A. Fordii* in the nursery and 1,000 plants had been transplanted to clearings. The seedlings made good growth and many of the trees fruited in 1931. Some of the seed produced was sown and germinated in 18 days. A portion of the crop from these plants was crushed and a sample of the oil obtained has been received at the Imperial Institute. Further seed was sown in April 1931 and one hundred acres had been planted by the end of that year. Seventy plants of *A. montana* have also been raised on this estate and are making good progress. Mr. Withers is inclined to think that this species will do better than *A. Fordii* in most of those parts of Assam which have an annual rainfall of from 60 to 100 inches, as he has found that the latter species does not grow so well where the rainfall is 80 inches as it does with a rainfall of 50 inches.

Small-scale trials have also been started by the Director of the Indian Lac Research Institute at Sabaya and Namkum in the Ranchi district of Chota Nagpur, Bihar and Orissa. *A. Fordii* trees have made good progress and started flowering towards the end of the second year.

Ceylon.—Repeated trials in Ceylon have shown that *A. Fordii* will not flourish in that island. *A. montana*, on the other hand, appears to grow well. At the Experiment Station, Peradeniya, there are some 36 trees of the latter

species which are just beginning to bear. A sample of the seeds has been sent to the Imperial Institute for examination.

British Malaya.—Experiments indicate that although *A. Fordii* shows considerable promise during the first year or so after sowing, subsequent growth appears to be arrested and the trees fail to flower or fruit. This is probably due to the absence of a cold season during which the plants may rest. With *A. montana* rather better results have been obtained. At the Government Experimental Plantation, Serdang, a small area was planted in 1925 with seed obtained from Hong Kong. By the end of three years a small number of the trees had fruited, one bearing as many as a hundred fruits. Upon chemical examination a sample of fruits from these trees was found to contain 43·2 per cent. of oil in the kernels. This yield is rather low, as two samples from China examined at the Imperial Institute gave yields of 56·3 and 59·8 per cent. respectively, expressed on the kernels (see this BULLETIN, 1930, **28**, 270). The position in British Malaya has been summarised by the Agricultural Department as follows: "As a result of the various trials carried out by the Department with *A. Fordii* and *A. montana* at the Experimental Plantations, Kuala Lumpur and Serdang, it would appear that both these species of *Aleurites* are unsuitable for cultivation on the plains in this country. Further trials, however, are being carried out at the Experimental Plantation, Cameron's Highlands, at an elevation of about 5,000 ft., and until such trials have proved successful the cultivation of either *A. Fordii* or *A. montana* on a commercial scale in Malaya cannot be recommended."

Australia.—As a result of a distribution of seed made several years ago from the Royal Botanic Gardens, Kew, to the Botanic Gardens, Sydney, there were in New South Wales at the beginning of 1930 about 1,000 *A. Fordii* trees, many of which were then in bearing.

In the Pennant Hills, Mr. Rawes Whittell and Messrs. Smith, Wylie and Co. (Aust.) had in 1931 over 6 acres planted; a company—Tung Oil (Australia) Ltd.—has been formed to develop this enterprise and proposes to establish a 1,000-acre plantation at Bundanoon near

Sydney. A sample of fruits grown by Mr. Rawes Whittell was recently received at the Imperial Institute for examination and found to contain a normal percentage of oil, which was of very similar composition to that of oil of Chinese origin.

In Queensland also the experimental cultivation of *A. Fordii* has been started, and according to private communications good progress is being made. The Department of Agriculture and Stock has established two experimental plantations of two and four acres respectively in the Mary Valley near Gympie, while in Innisfail District, Queensland Forest Ltd. has two plantations of 45 acres each.

New Zealand.—Seeds of *A. Fordii* have been sown annually for the past three or four years at the Government Horticultural Station at Te Kauwhata. The germination has been good and satisfactory plants have been raised without any special difficulty. As yearlings these plants have been set out in plantations or on farms in Auckland, Hawkes Bay and Nelson Provinces. There are a few trees eight years old in private gardens in the suburbs of Auckland. These have made normal growth and the trees have carried a small crop. It is considered that the most northerly parts of North Island are the only districts suitable, as there the frosts are rare and light. Should these parts of the Dominion prove satisfactory as regards soil and climate for the growth and fruiting of the trees a valuable industry might be established. The number of trees, however, that have been grown to maturity in the Auckland district is too small to enable a confident opinion to be formed of the future prospects of this industry. But the experimental trials already made in numerous localities by the Department of Agriculture and the State Forest Service should serve to indicate what parts, if any, are suitable for the establishment of large-scale plantations.

Five public companies with a total nominal capital of £780,000 have been formed to develop the cultivation of tung trees on a commercial scale in the North Auckland district. One of the five companies, the New Zealand Tung Oil Corporation, has acquired land at Kaukapakapa,

North Island, for the purpose of establishing plantations. Five hundred acres have already been planted. Another company, Paerenga (N.Z.) Tung Oil Ltd., has an estate in the extreme north-west corner of North Island. No trees had been planted out by last October, but there were sufficient seedlings in the nursery for 500 acres. The Northern Tung Oil Ltd. owns plantations in Mangonui district about 300 miles north of Auckland, and has about 500 acres under preparation. Other companies interested are Empire Wood Oil (N.Z.) Ltd. and Natural Products (N.Z.) Ltd.

Africa.—Experimental trials with tung trees are in progress in all British countries in South and East Africa from the Union of South Africa to Kenya. In the Union of South Africa Messrs. Banger and Allen on their farm at Bushbuck Ridge, Pilgrim's Rest, Transvaal, had in June 1930 about 400 three-year-old trees of *A. Fordii.* In February 1931 several of these were bearing fruit. A sample of fruits from a six-year-old tree grown on the same farm was received at the Imperial Institute and on examination was found to yield a normal percentage of oil of character similar to the tung oil of commerce.

At Groot Drakenstein, Cape Province, the Rhodes Fruit Farms Ltd. have successfully reared about 250 two-year-old seedlings of *A. Fordii.* In Natal trials carried out in several places have given results which in some cases were disappointing and in others satisfactory. Some of the trees raised by Imperial Chemical Industries Ltd. at their Umbogintwini factory in Natal have flowered fairly profusely and a number of fruits have set.

In Southern Rhodesia the Forest Officer, as the result of trials made in several places, is of opinion that *A. Fordii* will most probably grow in certain localities, but he does not think "it will ever thrive as a commercial tree." At Abercorn, Northern Rhodesia, one-year-old plants were reported to be doing well on the whole.

Results of trials with *A. Fordii* carried out in East Africa continue to be disappointing throughout the whole range of trials between sea-level at Zanzibar and 4,000–5,000 ft. in the Moshi-Arusha area of Tanganyika, though in the Mbeya district of Iringa Province a more promising

result appears probable. At Amani only two trees show any appreciable growth. In Kenya the Conservator of Forests considers it clear that the Nairobi climate does not suit the tree, but it may acclimatise itself in due course. Reports from other parts of the Colony show that the tree will make better growth at altitudes of 6,000 ft. and over and that the climate in these places at any rate appears to be more suitable.

Cyprus.—At seven experimental stations in different parts of Cyprus trials have been carried out with both species and the results have not been altogether encouraging, although in certain areas isolated plants seem to have attained some degree of development. Polis is the only station where trials on anything approaching a commercial scale have been made and there seem to be average prospects of success in this area. The Director of Agriculture stated last September that he was inclined to think that the extremes of temperature in Cyprus and the long summer and hot dry winds are not favourable to the growth of *Aleurites*, but the experimental plot now established at Polis should in due course give more definite information as to the possibility of cultivating these trees commercially.

Other Countries.—The results of trials made in other parts of the Empire have not been very promising. In some cases, experiments have shown that the trees will not thrive or fruit. This failure is often due in the case of *A. Fordii* to the absence of a cold season which prevents the tree from having the annual resting period which is essential.

In addition to the trials carried out in the United States of America and the British Empire, attempts are being made to cultivate Chinese wood oil trees in the following countries: Argentine, Paraguay, Brazil, Sumatra, Java, Portuguese East Africa, Madagascar, Cuba, Hawaii and the Philippine Islands. Of these trials the most important are those being made in South America. In the Argentine the most favourable area appears to be in the Provinces of Misiones and Corrientes and in the northern portion of the Province of Entre Rios. The greatest activity centres round San José and Pindapay in Misiones, where it is estimated there were some 50,000

trees last October. All the trees have made rapid growth and many have fruited. In Paraguay there are about 30,000 trees, the largest single planting being that made by the Paraguay Central Railway. With this exception most of the plantings consist of 25 to 500 trees each.

In connection with the cultivation of the trees the question naturally arises whether it is better to grow *A. Fordii* or *A. montana.* As far as present experience would indicate, it seems advisable to give preference, *ceteris paribus*, to the former species in view of the fact that, as already stated, most of the commercial supplies of Chinese wood oil are derived from this tree. Moreover, it has not yet been definitely established that the oil of *A. montana* possesses equal powers of gelation or is of equal value to *A. Fordii* oil. Investigations rather tend to show that it is somewhat inferior and takes a longer time to polymerise.

The influence of the increased production on the price of tung oil is another point which will occur to those who are contemplating engaging in this new industry. Will the larger quantities available have the effect of reducing the price to a figure which will render the cultivation of the trees unprofitable? On this question it must be stated that during the last two years the price of the oil has fallen considerably, as is shown by a comparison of the price in January 1930 of £69 10*s*. per ton in London for Hankow Chinese wood oil with that in September 1931 of £37 10*s*. This heavy fall in price was due largely to the lower value of silver and has been accentuated by the general decline in the prices of all commodities. During the last few months the price of tung oil has risen again owing to the depreciation in the value of sterling and was in February 1932 quoted at £51. It is considered, however, that tung oil will always command a price at least £10 per ton above that of linseed oil, on account of its special properties, which make its use essential in the manufacture of certain types of varnishes. It must also be remembered that new uses may be found for tung oil, which will result in a demand for increased quantities. A potential new use is in the linoleum industry, as it is possible that tung oil, on account of its property of

gelation, may prove more suitable for this purpose than the linseed oil now used and that the process of manufacture may be quickened and cheapened when tung oil is employed. Should this prove the case, large quantities of this oil will be required, as the linoleum industry in the United Kingdom alone uses some 50,000 tons of linseed oil annually.

It may be mentioned that tung oil produced on plantations should be of better quality and colour than the present supplies from China, because it will be prepared by modern machinery under skilled supervision. In addition, Chinese oil is often adulterated, while in the case of the plantation product the likelihood of such sophistication is remote. Therefore, unless the quality of the Chinese oil improves, the plantation oil should command a higher price and there should be a larger demand for this grade.

As will be seen from the above account considerable interest has been aroused by the steps that have been taken by the Imperial Institute Sub-Committee and others to encourage the production of tung oil within the Empire. In some countries commercial undertakings have been started to cultivate the tree. It should, however, be pointed out that it is very desirable that before the public are invited to subscribe funds for the establishment of plantations, definite evidence should be obtained by small-scale trials that tung trees can be successfully grown in the particular locality and that they are likely to prove a remunerative crop. Data are necessary as to the rate of growth of the trees, the age at which they will bear commercial supplies of fruit, the average yield of fruit per tree and the yield and quality of the oil. These particulars can only be obtained by establishing experimental plots of the trees in the actual locality and maintaining them for a period of years until they come into bearing. Until this preliminary work has been carried out, it is impossible to form a trustworthy estimate as to the probable commercial success of any scheme for the cultivation of the trees, and their planting on a large scale cannot be recommended.

BY-PRODUCTS OF THE SUGAR-CANE INDUSTRY

The following paper was communicated by Mr. W. G. Freeman, B.Sc., A.R.C.S., F.L.S., of the Imperial Institute, to the Imperial Sugar-Cane Research Conference, held in London, July 1931, and is reproduced, by kind permission of the Controller, His Majesty's Stationery Office, from the *Proceedings* of the Conference, published January 1932 (price 2*s.* 6*d.*). A set comprising most of the by-products mentioned in the paper has been placed on exhibition in the Public Galleries of the Imperial Institute.

The sugar-cane is grown primarily as a source of crystallisable sugar. All the sugars present in the cane cannot, however, be obtained in crystallised form, but can in great part be recovered in the molasses. By fermentation of molasses a palatable alcoholic drink, rum, is obtained, and from very early days of sugar-cane cultivation, molasses and rum have been well known as by-products. In some localities even to-day cane may be grown largely for a by-product, e.g. rum, the production of commercial sugar being of minor importance.

The fibrous portion of the cane, left after extraction of the juice, and known as bagasse or megass, has always been of great importance as the fuel for the evaporation of the cane juice. It was all required on the estate and often had to be supplemented by other fuel, and so had no value as a saleable by-product. Recent developments, however, have caused bagasse to become, in some countries, of use for other purposes and thus to have a commercial value as a by-product. The molasses can be used for the preparation of other forms of alcohol than rum; also for the manufacture on a large scale of yeast and "dry ice" (solid carbon dioxide).

With the low value now obtaining for the primary product—crystallised sugar—these by-products are becoming of increasing commercial importance.

The object of this paper is to give a brief summary of information relating to these various by-products. It has been based on a memorandum prepared by the Department of Scientific and Industrial Research in collaboration

with the Imperial Institute in September 1930, with some additions.

The products dealt with and their origin are indicated in the following table :

Bagasse—
- Paper.
- Artificial Silk.
- Fibre Board—Celotex and Vazcane.
- Feeding Stuffs.
- Explosives.
- Charcoal.

Molasses—
- Rum.
- Power Alcohol.
- Dry Ice (Solid Carbon Dioxide).
- Alcohol, Glycerin, Acetaldehyde and Dry Ice (combined production).
- Yeast.
- Fuel.
- Fertiliser.

Filter Press Cake—
- Wax.

Bagasse

The primary use of the bagasse is as fuel for the purpose of boiling down the sugar-containing juice extracted from the cane. In early days it was necessary to dry the bagasse in the sun, but now it is usually fed direct from the mills to the furnaces. The fuel value of bagasse is low, but modern improvements in the design of furnaces have resulted in much economy and in many of the more efficient factories there is no longer any necessity to employ additional fuel. In fact, there is frequently a surplus of bagasse which is available for other purposes. This will vary with the season. Thus, in a dry season with canes yielding a juice rich in sucrose, less fuel is required than in a wet season when the juice is of low sucrose content.

Should it be possible to make profitable use of bagasse as a by-product, Dr. F. Maxwell has suggested that it might be worth while to reduce the amount of sugar

extracted and increase the amount of bagasse available. Taking for example a typical large Cuban mill in which seven or eight milling units extract about 95 per cent. of the available sugar, requiring about 2,500 horse-power, the first three units of the train will extract some 85 per cent. of the sugar with an expenditure of about 1,000 horse-power. The units necessary to extract the final 10 per cent. require 1,500 horse-power. He has therefore suggested that if these, or some of these, were closed down to give a lower but more economical extraction, the bagasse saved (otherwise used as fuel) would be rendered available for other purposes.

Another possibility is to alter our views of the ideal cane and breed for fibre and sugar content as is being done in Louisiana and Florida. As put by E. L. Squires [1] :—" The cane production in the United States is being re-established on a sound basis with new varieties of cane, and a part of the production so allied with the bagasse board industry that sugar will almost be a by-product of this synthetic lumber." Or again [2] :—" Apparently bagasse is a very high-priced fuel and it might be better to burn the sugar."

There is also the possibility that in some countries some other fuel, e.g. oil, might be available at sufficiently low cost to allow all or part of the bagasse being put to other uses.

Paper

Dry bagasse contains about 40 to 50 per cent. of cellulose and many years ago attempts were made to utilise the fibre for the manufacture of paper. The material produced suffered from the defects of bad colour and harsh " rattly " texture. The paper had a satisfactory tensile strength but rather low tearing resistance and was suitable only for a wrapping paper or as a mulch in sugar-cane and pineapple cultivation.

Amongst recent trials may be mentioned one made by the Imperial Institute in 1929 with bagasse from

[1] " Some Economic Considerations of the Cuban Sugar Industry." *International Sugar Journal*, May, 1929, **31**, 243–250.

[2] " The Present Status of the Sugar Cane Industry in Cuba." *Ibid.*, August, 1929, **31**, 416–420.

Trinidad. The report[1] states this sample "furnished a good yield of pulp which easily bleached and yielded paper of excellent strength, but exhibited the 'rattly' character of paper produced from fibrous material containing pithy matter. By mechanical separation of the pith from the fibrous material it would no doubt be possible to produce paper of very good quality." It is suggested that good paper might be made by a fractional digestion process as applied to bamboos, or a chlorination process used in making straw pulp.

Another point is that owing to the seasonal nature of cane crushing some means of storing bagasse is necessary in order to provide a continuous supply to a paper-making plant. Owing to the rapid deterioration of bagasse this presents some difficulty.

Various commercial projects have been started, e.g. in Formosa, Hawaii and Cuba, but at present apparently very little, if any, bagasse is being used for the manufacture of paper. The question is, however, still being investigated by the Hawaiian Sugar Planters' Association.

Artificial Silk

Bagasse is also a possible raw material for the preparation of artificial silk.

An examination of Trinidad bagasse for this purpose was made by the Imperial Institute in 1928.[2] As for paper manufacture, the presence of pith is a defect, and this portion had to be removed as far as possible by rubbing and sieving, and by fractional digestion. The resulting material, about 40 per cent. of the original bagasse, digested with caustic soda, yielded a fairly long-fibred pulp which bleached readily to a pale cream and when dry could be fairly easily disintegrated by hand. Tests of the pulp indicated that bagasse is suitable for producing pulp similar in chemical composition to the wood pulp employed in the manufacture of artificial silk. Owing to the necessity for eliminating the useless pithy material the amount of pulp obtained represented only about 24 per cent. of the original bagasse, whereas, on a

[1] *Bulletin of the Imperial Institute*, 1929, **27**, 1–3.
[2] *Ibid.*, 3–6.

commercial scale, spruce yields from about 45 to 50 per cent. of pulp.

Various processes have been patented for the manufacture of artificial silk from bagasse. In 1927 a company erected a plant in Cuba for the production of pulp for paper and artificial silk. The original capacity of the plant was stated to be about 120 tons of pulp a day. In 1928 it was reported that its capacity was being largely increased in order to cope with the demand. Since then activities have practically ceased, and there is as yet no evidence that commercial success has been attained in the utilisation of bagasse for the preparation of cellulose on a large scale for artificial silk manufacture.

An interesting account of the position in Cuba was given by Joaquin de la Roza at the Fourth Annual Conference of the Association of Sugar Technologists of Cuba, 1930. The following is a summary [1] :

" When President Machado was presented last August with the first material to be made from the cellulose of bagasse, viz. a pair of ladies' rayon hose, ' there came to a successful close a long chapter of basic research and development, and officially a new industry was born in Cuba.' Now α-cellulose can be made from bagasse in the form of white sheets which are used by the artificial silk manufacturer as raw material in competition with that made from cotton. It is very doubtful if the fibre of bagasse contains much more than 40 per cent. of α-cellulose, though beta, gamma, oxy and other degraded celluloses may be present in greater or less proportion. Analytical methods used for its isolation from cane fibre consist of a series of mild chemical treatments designed to destroy or modify non-cellulosic substances ; but it is obvious that such methods besides being impracticable are too expensive to be used for the commercial production of this material. Success in developing suitable technical processes have been due, says the writer, perhaps more to faith and necessity than to anything else. That is, faith in the fact that bagasse is the world's cheapest and most plentiful source of cellulose, and the necessity of developing commercially this product of our industry to

[1] *International Sugar Journal*, 1931, **33**, 255–256.

enable it to meet the inroads of competition and adverse legislation.

"Since the author's first patents were filed in Cuba in 1925, the process developed in the laboratory has been transferred into a commercial reality on a very large scale. Conveying bagasse over long distances, for example, has been solved by blowing it through pipes of large diameter. Organic acids formed by the decomposition of sugar, said not to attack iron and steel, were found to be corrosive, and monel metal had to be used. After several years of work, at the plant at Central Tuinicu, the technical difficulties were finally overcome, and it was possible to produce a sufficient tonnage of 'Alpha Celulose Cubana,' containing an average of 97 per cent. of the actual α-compound, for shipment to various mills in the United States for trial in large-scale demonstrations. These tests proved that the α-cellulose made in Cuba as a competitor to purified cotton linters has become an accomplished fact, so that 'the new industry Celulosa will soon be the support of its sick sister sucrose.' (Patents dealing with Cellulose, taken out by the author of this paper, have been noticed by us, *I.S.J.*, 1929, 107; 1930, 221. One of these describes the following procedure: 'Preferably the fibre is crushed and washed in hot water before treatment with sulphurous acid, while the succeeding alkaline treatments may follow immediately, or later. Subsequent to the acid treatment, the fibre is washed in hot water and treated with a dilute solution of potassium or sodium hydroxide under pressure at from 140–170° C. It is finally washed and bleached. Alternatively, the alkali may be at atmospheric pressure, and below 100° C., the fibrous material being subsequently beaten in a pulping engine.'—Ed.)."

Fibre Board

Celotex.—An application of bagasse which was started some ten years ago and has now reached considerable proportions is the manufacture of fibre board. The process is in the hands of the Celotex Company and is centred at Louisiana although factories have been proposed in other sugar-cane producing countries. Work com-

menced on a small scale in 1920 and was operated commercially in 1922 when the output was 18 million sq. ft. of board. By replacing bagasse furnaces with suitable oil-burning equipment the boiler efficiency was increased from 55 per cent. to 70 per cent., so that the cane crushers were able to dispose of the bagasse to the Celotex Company at a fair profit. The earliest difficulty encountered was the removal of the large quantity of bulky material produced during the short crushing season of 60 to 90 days and its storage for use throughout the year. Special heavy balers were designed producing bales of 200 lb. to 250 lb., which were piled by cranes in dumps 60 ft. by 100 ft. by 30 ft. high. Precautions against spontaneous combustion are essential and a chemical treatment is given to prevent decomposition. Retting by storage under water or in an atmosphere of carbon dioxide is also employed to reduce the fibre to a more workable condition. The material at the mill is subjected to beating, digestion and washing under carefully controlled conditions until fibres of the requisite fineness and purity are obtained. The pulp of thin consistency is then supplied to the board-making machine, consisting of moulding rolls and presses, from which emerges a continuous sheet of board containing about 50 per cent. of water, which is removed in drying ovens several hundred feet long maintained at a temperature of 300° F. by superheated steam or by the products of combustion of natural gas. After drying, the board is seasoned by sprinkling with water to give the requisite amount of regain and it is then cut up by special machines into stock sizes for shipment. The material is light but strong, has excellent sound-proofing and heat-insulating properties, and finds many applications in building construction and industrial use. The sales figures are given as :

1922	18 million sq. ft.
1923	35 ,, ,,
1924	55 ,, ,,
1925	105 ,, ,,
1926	190 ,, ,,
1927	237 ,, ,,
1928	260 ,, ,,
1929	333 ,, ,,
1930	Over 500 million sq. ft.

Every effort is being made to organise the cane-growing side on the most efficient basis so as to reduce the cost of the fibre. Other developments of the Celotex Company are (1) a hard panel board capable of taking a high polish, (2) wrapping paper, (3) corrugated cardboard and also (4) a laminated paper product impregnated with resin.

The success of the Celotex Company in Louisiana appears to be largely due to the extensive scale of their operations and the availability of large supplies of bagasse close at hand supplemented by the enormous resources of Cuba.

For the sugar industry of a colony to benefit by the use of bagasse for the manufacture of fibre board it is essential that the industry itself should control the fibre-board factory. The mere sale of bagasse as a raw product is not likely to be very remunerative. There are moreover difficulties due to (1) the fact that the supply of surplus bagasse will be a very fluctuating quantity, dependent on the season, unless some other fuel can profitably be substituted in whole or in part, and (2) the question of storing the bagasse to which reference has already been made.

Vazcane.—Another method of board manufacture known as the Vazcane process, after its originator, E. A. Vazquez, effects considerable economy in plant by combining the sugar extraction and pulp-producing stages and so avoids duplication of crushers, boilers and filter presses. The raw cane as received at the mill is finely comminuted by grinding between rollers of artificial silicon carbide driven at 1,200 revolutions per minute. The rollers, which are ribbed, tear the canes into fine bundles of fibre and produce a pulp consistency of about 4 per cent. The pulp passes to a 12-stage counter-current washing system working on a bucket principle whereby 99 per cent. of the sucrose is extracted at a dilution of 30 per cent. The fibre pulp is discharged into a storage tank and is thence fed to a beater which breaks down the few remaining slivers. Rosin soap, copper sulphate and aluminium sulphate are added at this stage, the function of the precipitated copper resinate being to prevent mould growths. The pulp is fed from a stock tank to the board-

making plant of the usual type. The wet boards, 1 in. thick and measuring 4 ft. by 8 ft., are stacked in a drying press, the pressure being regulated according to the type of board required. At 100 lb. per sq. in. a ¼-in. board weighing 34 lb. per cubic foot is produced and finds extensive use for the manufacture of furniture, crates, doors, etc. A denser board, ⅛ in. thick, and weighing 68 lb. per cubic foot, was found too hard to cut without damage to the saws. The power required for the initial grinding, 18·3 kilowatts per ton of dry fibre per 24 hours, appears rather high, but when allowance is made for the sugar production and the saving in steam due to the heat generated by the grinding, a figure of 13·3 kilowatts is obtained, which compares very favourably with the 35 to 45 kilowatts consumed in grinding wood pulp for similar grades of wallboard. Only first-grade sugars are made in the plant and it appears likely that the value of the board will exceed that of the sugar. In an estimate based on a relatively small-scale trial, the output from a mill crushing 1,000 tons of cane per day would be :

	Value. $
Raw sugar, 122 short tons	5,490
Molasses, 30 short tons	210
Board (340,000 sq. ft), 110 short tons . . .	6,800

It has to be borne in mind that the adoption of the Vazcane process involves a radical change in the method of sugar manufacture and the replacement of existing mills and other equipment. It does not provide an outlet for any surplus bagasse from an ordinary factory.

In Jamaica a scheme for the erection of a Vazcane fibre-board factory on the Serge Island estate is well advanced. It is understood that at least £70,000 is needed for the venture ; that the Colonial Development Fund Committee has agreed to lend £20,000 free of interest for a certain number of years and that the Jamaica Government will guarantee the remaining £50,000, which will be subscribed for in the Colony.

Other Uses

Feeding Stuffs.—The finer part of the bagasse is used in some cattle foods, such as Molascuit. The bagasse

itself has very little food value but is of value as an absorbent of molasses. (See under Molasses.)

For Explosives.—The very fine portions of the bagasse, known as "bagasse flour," extracted by air suction, find a use in the manufacture of explosives, e.g. as an absorbent in place of kieselguhr in the preparation of dynamite.

Charcoal.—Charcoal briquettes can be made from bagasse and have possibilities of use as a substitute for coal in locomotives, etc., or in suitable gas-producer plants fitted to internal combustion engines.

Molasses

Molasses is another by-product of the sugar-cane industry for which many industrial applications have been found.

Rum

From very early days one of the principal uses to which molasses was put was to ferment it for the manufacture of rum. The effect of high taxation and prohibition in recent years has been to reduce considerably the world's demand for rum and increased attention has been given to producing alcohol from molasses for other purposes than human consumption.

Power Alcohol

Molasses is the cheapest raw material in common use for the production of alcohol for industrial purposes, the price being governed by supply and demand. Alcohol is a suitable ingredient of fuels for internal combustion engines, imparting to them certain anti-knock properties. Its manufacture presents no difficulties. It is mainly, therefore, the question of price in competition with petrol which determines whether it can be used profitably as a motor fuel. In South Africa a mixture of alcohol and ether is marketed under the name of "Natalite." In Queensland a motor spirit known as "Shellkol" is produced, consisting of a mixture of petrol, 85 per cent., and alcohol (from molasses), 15 per cent. In Brazil trials have been conducted with "Azulina," consisting of alcohol with 5 per cent. ether, denatured with 0·1 per cent.

of methylene blue. According to Dr. W. Freise[1] on a 500-kilometre trial on the Rio San Paulo main line with heavy mountain grades the fuel consumption was 1·40 litres of "Azulina" per kilometre compared with 1·0 litre of petrol. The local price of "Azulina" is, however, only half that of petrol.

It is stated that extremely large quantities of discarded sugar and molasses are available in Brazil and that there is an eagerness to invest capital in the new industry.

In Mauritius the production of power alcohol, to which attention had been given for several years, was made a success about 1926. The Report of the Department of Agriculture for 1929 notes that there are seven distilleries at work producing alcohol for human consumption and for industrial purposes. Uganda has a factory at Lugazi, established in 1925, which produces power alcohol for local consumption; some methylated spirit has also been exported. In 1929 the Industrial Alcohol Ordinance was passed, providing that all spirits distilled in the Protectorate must, with certain exceptions, be converted into denatured alcohol.

Dry Ice (Solid Carbon Dioxide)

A factor which may make molasses fermentation highly profitable is the value of the carbon dioxide produced. A fillip has been given to the carbon dioxide industry by the development of a new refrigerant known as "Dry Ice" and consisting of compressed solid carbon dioxide. In America carbon dioxide has been exploited very largely, being used principally for carbonating beverages, in refrigerating plants and for conserving foodstuffs. To compress carbon dioxide and transport it in cylinders was found unprofitable owing to high freight charges, but the conversion into solid carbon dioxide offers distinct possibilities of more economical working. The bulk of the carbon dioxide used by the Dry Ice Corporation, which has a manufacturing capacity of over 30 tons of "dry ice" per day, is obtained by the combustion of coke, but at Yonkers there is a plant producing 10 tons per day and

[1] "Alcohol Production for Motors in Brazil," *International Sugar Journal*, 1930, **32**, 404.

using the carbon dioxide from molasses fermentation. The purified gas is compressed in three stages, 75 lb., 300 lb. and 1,100 lb. After the first compression the gas is further purified by treatment with permanganate solution to remove traces of impurities, and is liquefied at 1,100 lb. pressure by cooling it to 70° F. in a condensing coil. The liquid is permitted to expand through a nozzle into a double wall tank with a filter cloth top and in this the "snow" is formed, the unchanged gas escaping through the cloth and being returned to the compressors. The "snow" is tamped in moulds and compressed at 500 lb. per sq. in. into a solid block. Forty to fifty per cent. of the liquid can be converted to solid in one operation. The cost of the "dry ice" is higher than that of ordinary water ice but its advantages have been found to outweigh the additional cost. On long railroad journeys the use of "dry ice" in refrigerated vans is decidedly advantageous as is shown by the following tabulation :

	Water Ice		Dry Ice
	Ice	Salt	
	lb	lb.	lb.
Original charge	12,000	1,200	1,200
Replaced first day	1,995	200	Nil
Replaced second day	1,950	195	Nil
Replaced third day	1,750	175	Nil
Total	17,695	1,770	1,200

Uses to which this material may be put are briefly :

(1) Light-weight packages of dairy produce, etc., for transport by post ; cardboard containers can be used without damage through wetting.

(2) Ship refrigeration on short passages to avoid installing plant.

(3) Storing of products at extremely low temperatures.

(4) Freezing quicksand, etc., in excavation work.

(5) Local anæsthetic.

A plant to manufacture solid carbon dioxide is shortly to be erected near Melbourne, Australia, using the "Carba" process, which is of Swiss origin. The liquid carbon dioxide at 15° C. is expanded through special alternating nozzles to about 5·2 atmospheres so as to give

a mass of "snow" wetted with liquid carbon dioxide. When the receptacle is full the expansion valve is closed and a valve at the bottom is opened, whereby the mass is frozen to a solid block owing to the evaporation of the liquid portion. The block is ejected from the bottom and is cut as required.

Combined Alcohol, Glycerin, Acetaldehyde and Dry Ice Production

The following summary [1] is given of a paper by N. M. Rydlewski in the Proceedings of the 1929 Annual Conference of the Association of Sugar Technologists, Cuba.

"During the European war, unable to obtain the necessary supplies for explosives, the Germans used the nitrogen from the air and the glycerin from the spent wash of their distilleries, the latter according to processes which have been greatly improved since, now giving excellent industrial and financial results. Several shipments representing average Cuban molasses have been sent to Germany for practical trials employing these new processes, and gave the following yields (per cent. molasses):—Glycerin, 29·38 (twice distilled); 94 per cent. alcohol, 23·52; and 75 per cent. acetaldehyde, 16·72 per cent., yields which are higher than at present obtainable from German beet molasses. Assume yields of only 24 per cent. of glycerin, equal to 2,880 lb. per 1,000 gall. of molasses; and 14 per cent. of acetaldehyde, equal to 1,680 lb. per 1,000 gall. of molasses. Assume further that the distillery is making motor fuel composed of 60 gall. of alcohol and 40 gall. of sulphuric ether, the following is the commercial value of the various products that would be obtained in a distillery working from 50,000 gall. of Cuban molasses daily by modern methods:—18,162 gall. of motor fuel at 29 cents per gall., $5,266; 2,050 lb. of fusel oil, 10 cents per lb., $205; 4,480 arrobas [2] of compressed carbon dioxide, $1 per arroba, $4,480; 144,000 lb. glycerin of 100 per cent., at 12 cents per lb. (18 cents in N.Y.), $17,280; and 84,000 lb. of acetaldehyde of 75 per cent. at 18 cents per

[1] *International Sugar Journal*, 1930, **32**, 430–431.

[2] 80 arrobas = one short ton; one arroba = 25 lb.

lb. (25 cents in N.Y.), $15,120. That is a total of $42,351. Against this one sets the following manufacturing expenses: —18,162 gall. motor fuel (inc. tax), 35·4 cents per gall., $6,429 ; 2,050 lb. of fusel oil without cost ; 4,480 arrobas of carbon dioxide (' dry ice '), 25 cents per arroba, $1,120 ; 144,000 lb. of glycerin, at 8 cents per lb., $11,520 ; and 84,000 lb. of acetaldehyde at 8 cents per lb., $6,720 ; that is a total cost of $25,789. This gives a gross profit of $16,562, which, less 25 per cent. for amortisation, taxes, insurance, administration charges, etc., leaves a nett profit of $12,421. Glycerin thus made would find a market all over the world without competition (the manufacturing cost of the product of soap manufacture being much higher); while acetaldehyde is used in large quantities in the paint industry, and is besides the principal base of many products. Carbon dioxide compressed to ' dry ice ' lasts ten times longer than water ice, is very hygienic and finds employment in many industries ; its loss by evaporation amounts to 10 per cent. per day. Hence the result of this study is that a distillery by working up 50,000 gall. of molasses, and producing glycerin and acetaldehyde in addition to alcohol motor fuel and the other by-products mentioned, can count on a daily nett income of $12,421 per day ; and the thought that occurs is the great possible value of the total molasses production of Cuba, amounting as it does to 250 million gallons per year."

Yeast

In America, molasses has been put to yet another use and that is for the production of yeast, either for fermentation and bread manufacture or for human consumption and cattle fodder. In Germany also, considerable advances have been made in breeding yeast cultures as a nitrogenous fodder for cattle. It is stated that 100 gall. of molasses will produce 50 lb. of fodder yeast or 400 lb. of baker's yeast. The methods of manufacture depend upon the initial composition of the molasses, and the treatments necessary for the preparation of a good yeast-growing medium are covered by a large number of patents. In general the process consists in diluting to a suitable consistency, adding other nutrient materials

such as phosphates, filtering, rendering alkaline with lime or caustic soda, decolorising with aluminium sulphate and again filtering. The ultimate aim is to create the most useful concentration of assimilable nitrogen for the growth of the yeast.

Feeding Stuffs

Molasses is used on sugar-cane estates as a feeding stuff. For purposes of transport an absorbent is desirable and in 1902 Mr. G. Hughes, of British Guiana, realised the possibility of using the finer portions of the bagasse for this purpose. The material so produced was called Molascuit and became an article of commerce. To make it a more complete food the deficiency in nitrogenous matter requires correction, and various leguminous seeds grown for the purpose, or readily available, in the producing country have been added when ground to the mixture. Deterioration may, however, take place during transport and on the whole it is preferable that the preparation of such feeding stuffs be carried out in the consuming rather than in the producing country.

Fuel

Molasses can be burned with good profit in ordinary factory furnaces, and with greater profit in furnaces of special though not expensive construction. In Australia all the northern mills, with the exception of some two or three, burn molasses as fuel in the furnaces without serious trouble in clinkering. In the Mackay area, one mill, Marian, utilises molasses as fuel. Many of the other Queensland mills have attempted to burn molasses with no good result, owing to clinkering in the fires. This seems to be due to the nature of the ash itself, which is composed of salts with high potash and soda content. Marian mill returns primary mud on the mills, and the extra lime has a decided beneficial effect in reducing the clinkering trouble. Experiments carried out in Java in 1923 showed that when burning molasses alone it was possible to evaporate 2·1 lb. of water by burning 1 lb. of molasses of 89·5 Brix in a special furnace. The boiler efficiency of the furnace was 50 per cent. No record of

the calorific value of Queensland molasses has been published, and an investigation on this matter is to be made by the Bureau of Sugar Experiment Stations, Queensland, in the near future.

In Java some factories burn a mixture of bagasse and molasses. The usual method according to Harrefeld [1] is to distribute the molasses in fine drops by a perforated pipe on the bagasse, as it leaves the last mill. If the molasses is very thick it has to be heated. The bagasse must be very fine so that the molasses is thoroughly absorbed before the bagasse reaches the furnace, otherwise there is trouble with slag, which also ensues if too much molasses is used.

In the Philippines trials are being made of the value of baled bagasse supplemented by molasses fed from atomising burners as fuel for locomotives. The cost of handling the surplus bagasse and molasses is stated to be about one-fifth that of the total cost of coal.[2]

Fertiliser

Molasses also has a fertiliser value, as it aids the nitrogen-fixing organisms and thus increases the nitrogen content of the soil, especially when lime is added. Molasses also contains an appreciable amount of potash which under appropriate conditions can be economically recovered. Molasses is burned, often after admixture with bagasse, in specially designed furnaces. The crude molasses contains between 3 and 6 per cent. of potash and the efficiency of the recovery determines whether the operation is profitable or not. With careful supervision a recovery of 79 per cent. is possible. One type of burner will consume 140 tons of molasses in 210 hours. 11·15 tons of molasses yield 1 ton of ash containing 27·74 per cent. of potash (K_2O). The actual recovery is about 50 lb. of potash per ton of molasses.

[1] "Extra Fuel in Java." *Transactions of the International Society of Cane Sugar Technologists*, Cuba, 1927. Summary in *International Sugar Journal*, 1928, **30**, 558.

[2] "Utilisation of Surplus Bagasse and Molasses for the Production of Fuel for Estate Locomotives." T. Nickelson. *Committee Reports of Fifth Annual Convention of Philippine Sugar Association*, 1927. Summary in *International Sugar Journal*, 1928, **30**, 227–228.

Filter-Press Cake

Wax

Reference must also be made to an important constituent of the filter-press cake, namely, the cane wax. This wax is extracted by means of industrial alcohol giving a recovery of 4·06 to 5·27 per cent. Benzene is more efficient, but less profitable, owing to losses by evaporation, etc., and also the alcohol can be prepared on the spot by fermentation of molasses. The wax finds application in the shoe-polish, candle and sealing-wax industries. The chemical composition is somewhat complex. The residue after extraction of the wax has a considerable value as fertiliser.

NOTE ADDED

Since the Conference was held there has been received the *Report of the Sugar Enquiry Committee*, 1931 (The Parliament of the Commonwealth of Australia, No. 240, F. 971). A Section of the report, pp. 14–28, is devoted to the utilisation of sugar by-products. It is clearly demonstrated that such utilisation, to be economically successful, depends on local conditions. For example, in Australia, with no cheap alternative fuel available, it would appear impossible to divert bagasse from its primary function as fuel. The problems in connection with the production of power alcohol and other products are also dealt with from the economic standpoint.

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NOTES

Silk in the Empire.—In a paper read before the Royal Society of Arts on November 24, 1931, and published in the issue of the *Journal* of the Society for December 25, 1931 (Vol. 53, No. 4127), Mr. Norton Breton, Chairman of the Imperial Institute Advisory Committee on Silk Production, gave an account of the present position of sericulture in British countries. He stated that the production of raw silk within the Empire *for the needs of the weaving industries of the western world* is negligible, but he pointed out that there is an enormous production of cocoons in India which are used locally, and referred to the silk industry of Cyprus which has long had an important production of cocoons. The Empire's silk entering the world's markets is produced in Kashmir and Cyprus. The deficiencies of the Empire's resources in raw silk led to the formation in 1916, under the chairmanship of the late Sir Frank Warner, of the Advisory Committee on Silk Production at the Imperial Institute, which has as its main object the finding of new fields for silk-raising in British overseas countries. The position of Cyprus was investigated by the Committee and after exhaustive technical trials of the cocoons, which gave most satisfactory results, arrangements were made for private enterprise to erect and work a modern silk filature for reeling the cocoons which hitherto had been exported to France for reeling, the silk thus losing its identity. The silk produced by this filature has already earned a high reputation in this country.

Passing to the Kashmir industry and the promising quality of the silk, and then referring to the present state of the silk industry in other parts of India and the technical and industrial considerations which now render the use of the silk there produced uneconomical in western factories, Mr. Breton described the Committee's investiga-

tions in regard to the prospects of silk in other British countries, including Uganda, Tanganyika Territory, Nyasaland, Rhodesia, the Union of South Africa, Sudan, Jamaica, Australia, Palestine and Iraq. The experiments carried out in a number of these countries were sufficiently promising for the governments of the five first mentioned to desire an expert report on their silk-raising potentialities, and, at their invitation, Mr. Breton visited Africa in 1929–30 and reported to the respective governments. The reports were favourable, but circumstances have as yet hindered the governments concerned from taking action in the desired direction. Mr. Breton illustrated his lectures with specimens of the silk produced in British countries and with a series of fabrics woven from the silks in the works of members of the Committee.

Dry Rot in Buildings.—The Department of Scientific and Industrial Research have issued as *Leaflet No.* 6 (*Forest Products Research*) a useful account of Dry Rot in Buildings, prepared at the Forest Products Research Laboratory, Princes Risborough. The publication may be regarded as a special aspect of *Forest Products Research Bulletin No.* 1 (" Dry Rot in Wood ") issued in 1928.

In non-technical language the leaflet deals with the recognition, prevention and cure of dry rot. Attention is drawn to the importance of accurately diagnosing the " rot " encountered, and to the fact that, although certain relatively harmless fungi may for the time being be the only organisms present, their occurrence is a danger signal since damp conditions, favourable to an attack of dry rot, evidently already exist. Large photographs illustrate characteristic appearances of timber attacked by *Merusliu lacrymans*, the true dry-rot fungus, and *Coniophora cerebella* (*puteana*), the cellar fungus.

The best accepted practice for the prevention of rot is stated. As is well known, " the most efficient way to reduce outbreaks of dry rot is to design houses and buildings with proper and adequate ventilation." Practical details accompany this truth and reference is made to the fact that wood is often infected with the spores of the fungus, picked up in the timber yard, before it is built into a house. The treatment of timber with a suitable preservative before being used in suspected cases, or where it is known that the house is likely to be damp, is a precaution of obvious value.

The cure of dry rot is often an expensive and drastic operation. The cutting out and burning of infected wood is described, and treatment of remaining timber and of

new wood used for replacement is recommended. Solutions of sodium fluoride, acid magnesium silico-fluoride and zinc chloride are mentioned as satisfactory fungicides which can be employed where the odour of the invaluable creosote and allied proprietary solutions render the use of these fluids unsuitable. It should be mentioned, however, that these substances should not be used in other than approved strengths of solution. Fuller particulars regarding the general question of dry rot, and the methods of using preservatives will be found in *Bulletin No.* 1 (1928) referred to above.

Iroko (or Odum).—Two short papers on Iroko (*Chlorophora excelsa* Benth. and Hook. f.) appear in *Tropical Woods*, No. 28 (December 1, 1931). C. Vigne (Assistant Conservator of Forests, Gold Coast) gives an account of the species yielding the timber in the Gold Coast, where it is known as Odum. The tree is said to be probably the most valuable forest species in the colony. The timber is seldom exported since there is a steady local demand for it and it is stated that the price obtainable in Europe does not justify the expense of extracting the logs, which are heavy and cannot be floated. *Chlorophora excelsa* is well distributed throughout the greater part of the closed forest area; it is absent from the savannah forest and rare in the rain forest, though fairly common in the secondary forest, having been left standing at the original clearing. The tree is a large one with a clear bole and a spreading crown of large branches, and has male and female flowers borne on separate individuals. Seed is plentiful and readily germinates, giving rise to vigorously growing seedlings which, however, appear to have been attacked by a gall fly almost invariably in the plantations established in the Gold Coast. Fortunately, evidence exists that the saplings may recover from the attacks in due course.

Exploitation of the timber is in the hands of natives, the methods of conversion being very wasteful. The wood floats when dry, but green timber sinks. On the analogy of Burma teak, an experiment was made to test the effect of girdling, but a log cut from a tree killed two years previously by girdling sank when thrown into the river. The timber is largely used by the Government and the native and trading communities, chiefly for house building and furniture, for which purposes its strength, durability and appearance render it very suitable. Heavy demands are exhausting readily available supplies, but additional sources of Odum are being opened up by new roads. The

rapid increase in the number of permanent native houses is a serious menace to the duration of supplies, which it seems difficult to secure by plantings in face of the gall fly menace.

E. H. B. Boulton and T. J. Price, in the same journal, publish some "Notes on Iroko," explaining that the timber on the English market comes mostly from Nigeria, while French supplies are largely from the Ivory Coast. Numerous indigenous names recorded for the tree are quoted with the countries concerned, which stretch from West Africa to the Congo, Portuguese East Africa and Uganda. Reference is made to the unsuitability of the English trade names of African teak and African oak which (more especially the former) are applied to the wood. Iroko is imported into England as hewn squares, 14–24 ft. long and 24–42 in. wide, while France imports considerable supplies in the round. In this country the timber is becoming appreciated for laboratory fittings, fascias, counter and table tops, sign posts, draining boards and parquet flooring. In France it is employed for similar purposes and for carpentry, vehicle frames and ship and boat building.

The wood is moderately hard and heavy ; works easily, and, with careful filling, takes a high polish. The authors give an account of the minute anatomy of the wood and also the results of shrinkage tests carried out by them. In drying to about 13 per cent. moisture content, the average radial shrinkage (on a basis of dry width) was 0·94 per cent. ; tangential, 2·04 per cent.

The Belgian Flax-growing Industry.—The following information is taken from the Report issued by the Department of Overseas Trade on the Economic Conditions in Belgium in 1930, by Mr. N. S. Reyntiens, Commercial Secretary to the British Embassy at Brussels.

The 1930 flax crop suffered from adverse weather conditions and the yield was less satisfactory than the 1929 crop. At the same time prices slumped badly, and what fetched 11–13 francs per kilo. at the end of 1929 could be bought at 6–7 francs nine months later. These conditions spelt ruin to many of the flax growers, scutchers and dealers, and discontent was openly voiced against the alleged dumping of Russian flax, which is considered responsible for the prevailing state of affairs. It was concluded from all indications that in 1931 the peasants would go in for less flax growing, and a tightening of prices for home-grown flax towards the end of 1930 and during the winter was not improbable as a consequence thereof.

As a matter of fact, after a period of years during which fears were always entertained in regard to a possible flax shortage, there is now a superfluity of this commodity compared with the capacity of the market to absorb it. The Belgian flax market is also said to suffer from old-fashioned sales methods and a plethora of middlemen.

The area of flax sown in 1930 was 22,770 hectares, as compared with 27,618 hectares in 1929.

According to a competent authority the estimated cost per hectare of flax of medium quality in Belgium is as follows :

	Frs.
Hire of 1 hectare land, Scheldt district	3,500·00
Manuring 800 kilos.	1,200·00
Sowing seed, 160 kilos. at frs. 4·35 per kilo.	696·00
Weeding	200·00
Pulling	1,100·00
Tying and stacking	370·00
Transport, unloading and storing 5,000 kilos. at frs. 15 per 100 kg	750·00
Cost of 1 hectare delivered to barn	7,816·00
De-seeding 5,000 kilos. at frs. 12 per 100 kilos.	600·00
Retting :	
Hire of crates	120·00
Labour	1,300·00
Straw for tying bundles, 200 kilos. at frs. 55 per 100 kilos.	110·00
Scutching 700 kilos. at frs. 3 per kg.	2,100·00
Hire of scutching handles, 46 days at frs. 6 per day	276·00
Cost of one hectare for de-seeding, retting, etc.	4,506·00
Total estimated cost of the produce from 1 hectare	12,322·00

For these calculations, following is the basis taken :

Dried straw	5,000 kilos. per hectare
Scutched straw	700 „ „ „

International Organisation of Chocolate and Cocoa Manufacturers.—A Congress of Manufacturers of Chocolate and Cocoa was held in 1930, in connection with the Antwerp International Colonial Exhibition. Representatives of nearly thirty different countries attended and matters of great interest to the industry were discussed. The proceedings of the Congress and the papers and discussions contributed to the meetings have been published in two volumes, viz. (1) *Volume Préparatoire* (pp. 384, 9¾ × 6½, price 150 francs belges or 30 belgas), and (2) *Compte Rendu Officiel* (pp. 226, 9¾ × 6¼, price 100 francs belges or 20 belgas).

The Congress devoted considerable attention to the possibilities of securing international agreement on such matters as definitions and standards for cocoa and chocolate, standard weights and sizes for chocolate, and the establishment of an International Office for cocoa and chocolate manufacturers. The opinions of the repre-

sentatives of the participating countries and the conclusions reached are given in the volumes.

There are also a number of useful papers of general interest which afford valuable summaries of the subjects with which they deal. Amongst these may be mentioned the contributions on cocoa production in various countries, the desirable qualities in raw cocoa, the importance of cocoa in relation to diet and health, cocoa-butter substitutes and methods for their precise identification, means of determining the sugars in chocolate, and on vanilla and vanillin.

One outcome of the Conference was the establishment of the Office International des Fabricants de Chocolat et de Cacao, which was granted civil status as an International Association with a scientific aim by Royal Decree dated December 29, 1931. This organisation is issuing a journal (*Bulletin Officiel de l'Office International des Fabricants de Chocolat et de Cacao*), the first number of which appeared in January 1931. Ten numbers will be issued annually at a subscription of 30 belgas.

On the evidence of the numbers already published the *Bulletin* will be a very useful addition to the literature on cocoa and cocoa products. The papers in the ten numbers issued in 1931 deal with a very wide range of subjects, including cultivation in various countries, manufacturing processes, chemical work in relation to cocoa and its products, an account of research work in Great Britain, international propaganda and other activities, statistical information, market prices, etc.

Whilst French is the official language of the *Bulletin*, papers appear also in English, German, etc., according to the nationality of the author, with usually at least a summary in the five principal languages.

The *Bulletin* will be of much interest and value to both planters and manufacturers, and as such is worthy of support in both producing and consuming countries.

The address of the Office International des Fabricants de Chocolat et de Cacao, from which copies of the Congress reports and the *Bulletin Officiel* are obtainable, is: 69 Rue Ducale, Brussels, Belgium.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Acting Colonial Secretary the following report on the work carried out by the Mines Branch of the Land Registration and Survey Department during the last six months of 1931.

Mining activities continue to suffer from the effect of the general depression in trade, and the larger operating mines have had to effect further curtailments, with a consequent decrease in the output of mineral from the Colony.

I. Metallic Minerals

(A) *Pyrites*

(1) *Cyprus Mines Corporation, Skouriotissa Mine*

	Last 6 months 1931.	Last 6 months 1930.
Mineral mined . . . . . *tons*	86,088	93,814
Labour, underground only *average per day*	412	538
Mineral exported . . . . . *tons*	94,724	103,250
Labour, total surface and underground *average per day*	996	1,211

(2) *Cyprus Mines Corporation, Mavrovouni Mine*

	Last 6 months 1931.	Last 6 months 1930.
Boreholes (surface) footage sunk . .	nil	2,022
Prospect drilling (underground) . *ft.*	6,826	nil
Development, total footage . . .	5,691	3,706
Mineral mined . . . . . *tons*	30,676	11,668
Labour, underground only *average per day*	254	340
Mineral exported . . . . . *tons*	21,211	5,872
Labour, all operations . *average per day*	579	655

(3) *Cyprus Sulphur & Copper Co., Ltd., Lymni Mine*

	Last 6 months 1931.	Last 6 months 1930.
Underground, development footage . .	533	537
Opencast, overburden removed *cub. yds.*	28,148	nil
Mineral mined . . . . . *tons*	1,175	748
Copper precipitate produced . . *tons*	8	nil
Labour, all operations . *average per day*	74	70

(B) *Chrome Iron Ore*

Cyprus Chrome Company, Ltd., Troodos Mines

(Mining Lease and Prospecting Permit areas)

		Last 6 months 1931.	Last 6 months 1930.
Development, total footage		327	384
Mineral mined	*tons*	nil	1,215
Mineral exported	*tons*	nil	nil
Labour, all operations	*average per day*	25 [1]	47

[1] *For three months only.*

II. Non-Metallic Minerals

(A) *Asbestos*

Cyprus Asbestos Company, Ltd., Amiandos

		Last 6 months 1931.	Last 6 months 1930.
Rock mined	*tons*	97,620	413,077
Rock treated	*tons*	23,307	103,084
Finished asbestos produced	*tons*	1,123	4,964
Finished asbestos exported	*tons*	1,521	2,336
Labour, quarries only	*average per day*	124	652
Labour, all operations	*average per day*	287	901

(B) *Other Minerals, Exported*

		Last 6 months 1931.	Last 6 months 1930.
Terra umbra	*tons*	1,405	1,614
Terra verte	*tons*	1	15
Gypsum	*tons*	5,749	4,809
Building stone	*cub. yds.*	428	230

Errata.—The following corrections should be applied to figures supplied in the last report in respect to the output of the Cyprus Asbestos Company, Ltd., Amiandos (this Bulletin, 1931, **29**, 342).

		First 6 months 1931
Finished asbestos exported	*tons*	607 to read 2,049
Labour, all operations	*average per day*	296 to read 217

FEDERATED MALAY STATES

The Imperial Institute has received from the Acting Director of the Geological Survey the following account of the work carried out during the six months ending December 31, 1931.

Satisfactory progress was made by Mr. H. E. F. Savage, Assistant Geologist, on the geological map of the country around Sungei Siput North, based on the topographical map, scale 1 in. = 1 mile. A newly-cleared area of Jalong Tinggi Estate, where limestone, schist, granite and quartz occur, all in a hilly area of about 100 acres, afforded an excellent example illustrating how these rocks produce

different types of soil, and chemists from the soils divisions of the Department of Agriculture and of the Rubber Research Institute were taken to the locality to make a thorough examination. It is hoped that a joint paper will soon be prepared on the subject.

Deposits of brick clay were discovered in the Sungei Siput area, near good roads, but some distance from the nearest railway-line.

A Malay Assistant was attached to a party sent out by the Forest Department for work in the jungle-covered mountainous country east of Cameron Highlands, and from the specimens he collected, the country rock is seen to be granite, with pegmatite, aplite and allied rocks. He washed up concentrates, all of which were rich in tourmaline, biotite, zircon and ilmenite, with smaller quantities of muscovite, chlorite, epidote, leucoxene, monazite, apatite and topaz, and occasional grains of rutile and garnet, and with traces of cassiterite in a few samples.

Crystalline limestone, of Carboniferous or of Permo-Carboniferous age, occurs in large quantity in the Kinta Valley, as hills with steep or even vertical cliffs hundreds of feet above the valley-floor, and also as a flat pavement, once washed by the sea-waves, and since incised by streams and covered with alluvium. In two recent publications, *Coral Reef Rock*, by P. Marshall (Fourth Pacific Science Congress, 1929, vol. ii B, p. 863), and *Java's Zuid Kust bij Tji-Laoet-Eureun*, door J. H. F. Umbgrove en J. Cosijn, cases have been described where coral limestone which has been exposed to the combined action of salt water and surf has thereby been dolomitised, and the question arises how far the dolomitisation of hard crystalline limestone might have been effected under similar conditions. Mr. Shenton, the Chemist, has shown that, in the few cases of limestone-pavements in Kinta he has already dealt with, the skin of rock forming the flat upper surface definitely is richer in magnesia than the limestone a few inches below, but it is realised that this may be due to preferential solution by ground-water, calcite being more soluble than dolomite. Many more tests are contemplated, but they can only be done during intervals of other work.

GOLD COAST

The Imperial Institute has received from the Director of the Gold Coast Geological Survey Department, Dr. N. R. Junner, a report on the research work carried out by the Department during the half-year ended December 31, 1931.

During the greater part of the period under review the officers of the Survey were engaged in research work on the material collected during the previous field tour. The research work included the following items: (*a*) The preparation for publication of a report on the geology of the Obuasi goldfield, Ashanti. This report (*Memoir No. 2 of the Geological Survey*) is now in the press. (*b*) The preparation of a geological map of the Nsuta manganese deposits. (*c*) The preparation of a report on the Cinnamon Bippo mine, and a map of the north-eastward extension of the banket and associated Tarkwaian beds from Aboso to the Central Province Railway near Damang. (*d*) The examination of a large number of concentrates and thin sections of rocks from the Birim diamond-field and other areas. (*e*) The preparation of a report of the stratigraphy of the Gold Coast for inclusion in the *Lexicon de Stratigraphie* of the International Geological Congress.

The Director and two geologists returned to the Gold Coast in November. Since that date one of the geologists has been engaged in an investigation of the water-supply potentialities of the Akwapim range and the Shai plains and hills. The other geologist mapped the geology of the Sekondi township, and is now assisting the Director in an examination of portions of the Tarkwa and Axim Districts.

The third geologist is attending a course of instruction in Applied Geophysics at the Imperial College of Science and Technology, London.

NIGERIA

The Imperial Institute has received from Dr. R. C. Wilson, Director of the Geological Survey of Nigeria, the following report on the work of the Survey during the period July to December, 1931.

General.—During the period under review the activities of the Geological Survey have been devoted entirely to water-supply projects in the Emirates of Sokoto, Bornu and Hadejia.

Sokoto.—The experimental deep shaft in Sokoto City, of 9½ ft. finished diameter, was sunk to tap the Rima Sandstone aquifer and to test the possibility of obtaining a good supply of water from it. The shaft reached water at the 153 ft. level in September and the caisson was then sunk for a depth of 12 ft. 9 in. into the aquifer. Exhaustive pumping tests were carried out over a period of some weeks and proved the economic yield to be 28,000 gallons per day. The shaft has now been completed and

schemes are being considered for the future development of the water-supply resources of this town.

At *Dange,* another large town with a very scanty water supply, a number of shafts are in the process of construction which it is hoped will considerably ameliorate conditions there. At the same time operations along the main motor road to Zaria, and in the bush adjacent to it, have been continued and a number of wells have been brought into production.

Enquiries from the various District Heads concerned show that the earlier wells constructed in the *Gundumi Bush* are highly appreciated by the people and that settlement is taking place around all of them, with the exception of those which are reserved for cattle.

Bornu and Hadejia.—In Bornu and Hadejia Emirates sinking operations have proved successful and in each area thirty shafts were sunk to water during the period February to December, 1931. In that part of Bornu Emirate which lies near the boundary of the crystalline rocks the ground has been very hard and the wells deep. Two of these reached water at depths of 242 and 235 ft. respectively, while others are still in the process of sinking.

The most important feature, however, of the work in these areas has been the recognition of the fact that lying at no great depth below the ordinary ground water is a second aquifer which, when it can be tapped, gives sub-artesian rises of 10 to 25 ft. Efforts are now being made to sink all shafts to this aquifer, but where the flow of ground water is heavy this is a difficult matter in the absence of pumps. In some cases it has not been possible to control the ground water by intensive and continuous pulling. In view of the fact that throughout these districts large herds of cattle are watered daily at these wells it is very desirable to pierce the lower aquifer wherever possible, otherwise the supplies of water available are not sufficient for the requirements of the people and serious overdrawing of the wells results.

Trainees.—The system of trainees for shaft sinking initiated during the year is proving a success and there has been a definite advance in the ability and efficiency of the personnel. The object of the scheme is to instruct natives of these particular Emirates in the construction of wells so that the scope of the work can be extended considerably without, at the same time, unduly increasing the European staff. One crew has already sunk and lined a shaft to 176 ft. with supervision but once a week and another has sunk to 190 ft. with supervision twice

a week. These results were obtained in Sokoto, where work has been in progress since 1929, and it is not to be expected that labour should be so far advanced in the other Emirates. The results obtained there, however, are very encouraging considering that work was commenced only eleven months ago and that the labour then available was quite unskilled.

UGANDA

The Imperial Institute has received from the Director of the Geological Survey of Uganda the following report on the work carried out during the second six months of 1931.

Mr. E. J. Wayland made a geological reconnaissance of parts of the Gulu, Chua, West Nile and West Madi areas and reached the conclusion that the gold which is so widely distributed in small quantities in the streams of West Nile and Madi is being derived from older gravels belonging to a pre-existing and probably quite different system of drainage, and that therefore a first need for detailed prospecting in these areas is a knowledge of the early riverine systems; and having flown over the area he decided that an air survey would be extremely helpful in this matter. The opportunity provided by the fact that an air survey of the Nile was being made was taken advantage of by the Uganda Government to have a part of the West Nile district air surveyed.

The geological survey of part of Koki was continued by Mr. W. C. Simmons, and further drilling work was done in another of the bare hollows previously described (this BULLETIN, 1931, **29**, 351). No further signs of economic minerals were found. In the area close to Lwanda, Koki, which lies thirty miles south-west of Masaka, and twenty miles west of Lake Victoria, Mr. Simmons discovered several good sections showing the Karagwe-Ankolean shales and quartzites resting unconformably upon ancient mica-schists and staurolite-schists. This junction was mapped along a line running north and south for a distance of seven miles, and was of interest as the base of this K.-A. system had not previously been seen.

On his return from leave in September Mr. A. D. Combe completed for the press his memoir on *The Geology of South-West Ankole and Adjacent Territories, with special reference to the Tin Deposits.*

The range of hills near Nakasongola, which lies seventy miles due north of Kampala, were visited by Dr. K. A. Davies for the purpose of a rapid geological reconnaissance,

and he found that they were mostly granites and syenite, but owing to the heavy soil mantle over the country rocks in the lower ground surrounding the hills the country was found to be difficult to prospect.

There has been in the last six months an awakening of interest in public prospecting, so that more specimens have reached the Geological Survey Laboratory for identification, analysis or assay. Dr. A. W. Groves continued his work on the Charnokite Series mentioned in the report for the first half of the year, and was able to complete chemical and micrographic analyses before he relinquished his appointment and went on leave at the end of September. A fine series of specimens of copper ores, some of which contain nickel and cobalt, has been received from Kilembe (Toro) and prospecting is being continued. Of considerable interest were numerous concentrates received from Kigezi which contained gold and wolfram, and prospecting is there also being continued.

The following table of mineral exports from Uganda is provisional:

Minerals exported during the Year 1931

Ascertained Figures			Provisional Figures		
Mineral	Weight	Value	Mineral	Weight	Value
	Tons.			*Tons*	
Metallic tin .	75·354	£8,371	Tin ore . .	30·428	£2,769
Ditto . .	10·806	£1,169			
	Troy ozs.			*Troy ozs.*	
Fine gold .	30·129	£171	Raw gold .	35·465	£195
Fine silver .	1·13	£·096			

BIBLIOGRAPHY

Comprising the more important reports, articles, etc., on plant and animal products contained in publications received in the Library of the Imperial Institute during the three months November, 1931 January, 1932.

The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4, Millbank, Westminster, S W.1. Applications for Dominion and Indian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.

AGRICULTURE

General

Agricultural Research in 1930 Issued by the Royal Agricultural Society of England Pp 201, 8½ × 5½ (London · John Murray, 1931.) Price 1s. A survey of the research work carried out in the United Kingdom during 1930 on crops and plant breeding, dairy husbandry, agricultural economics, agricultural engineering, animal nutrition, soils and fertilisers and veterinary science

Report and Proceedings of Conference of Colonial Directors of Agriculture, held at the Colonial Office, July 1931. Pp. 81, 9½ × 6. (London: H.M. Stationery Office, 1931.) Price 1s. 3d.

Report on the Department of Science and Agriculture, Barbados, for the Year 1930-31. Pp. 105, 13 × 8¼. (Barbados: Advocate Co., Ltd., 1931.)

Report of the Department of Agriculture, Bermuda, for the Year 1930. Pp. 59, 13 × 8¼. (Bermuda: Department of Agriculture, 1931.)

Annual Report of the Department of Agriculture of the Province of Alberta, Canada, for the Year 1930. Pp. 108, 10 × 6½. (Edmonton: King's Printer, 1931.)

Report of the Minister of Agriculture, Province of Ontario, Canada, for 1930. Pp. 72, 9¾ × 6½ (Toronto: King's Printer, 1931.)

Report of the Superintendent, Experimental Station, La Ferme, P.Q., Canada, for the Year 1930. Pp. 59, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

Administration Report of the Director of Agriculture, Ceylon, for 1930. Pp. 115, 9¾ × 6. (Colombo: Government Record Office, 1931.) Price Re. 1.15.

Annual Report of the Department of Agriculture, Cyprus, for the Year 1930. Pp. 55, 13 × 8¼. (Nicosia: Government Printing Office, 1931.)

Reports on the Agricultural Department, Dominica, for 1929–30 and 1930–31. Pp. 41, 12¾ × 8¼. (Trinidad: Imperial Commissioner of Agriculture for the West Indies, 1931.) Price 6d.

Review of Agricultural Operations in India, 1928–29. Pp. 248, 9¾ × 7¼. (Calcutta: Government of India Central Publication Branch, 1931.) Price Rs. 3-2 or 5s. 6d.

Annual Report of the Department of Agriculture, Bengal, for the Year 1930–31. Pp. 206, 9¾ × 6½. (Calcutta: Bengal Secretariat Book Depot, 1931.) Price Rs. 4 or 6s. 9d.

Report on the Operations of the Department of Agriculture, Burma, for the Year ended March 31, 1931. Pp. 74, 9¾ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 1–8 or 2s. 3d.

Report of the Economic Botanist, Burma, for the Year ending March 31, 1931. Pp. 10, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 4 or 5d.

Report on the Hmabi Agricultural Station, Burma, for the Year ending March 31, 1931. Pp. 44, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 1–8 or 2s. 3d.

Annual Report of the Principal, Agricultural College and Research Institute, Burma, Mandalay, for the Year ending March 31, 1931. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 6 or 7d.

Combined Report of the Akyab Agricultural Station and Kyaukpyu Coconut Farm, Burma, for the Year ended March 31, 1931. Pp. 19, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 12 or 1s. 1d.

Report of the Allanmyo Agricultural Station and Sub-Stations, Burma, for the Year ended March 31, 1931. Pp. 14, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, Burma, 1931.) Price Annas 8 or 9d.

Report on the Kanbalu Agricultural Station, Burma, for the Year ending March 31, 1931. Pp. 21, 9¾ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 8 or 9d.

Report on the Mahlaing Agricultural Station, Burma, for the Year

ended March 31, 1931. Pp. 19, $9\frac{3}{4} \times 6\frac{1}{4}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 12 or 1*s.* 1*d.*

Report on the Mandalay Agricultural College Farm, Burma, for the Year ended March 31, 1931. Pp. 20, $9\frac{3}{4} \times 6\frac{1}{2}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Re. 1 or 1*s.* 6*d.*

Report on the Mudon Agricultural Station, Burma, for the Year ended March 31, 1931. Pp. 37, $9\frac{3}{4} \times 6\frac{1}{2}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Re. 1 or 1*s.* 6*d.*

Report on the Myaungmya Agricultural Station, Burma, for the Year ended March 31, 1931. Pp. 21, $9\frac{3}{4} \times 6\frac{1}{2}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Re. 1 or 1*s.* 6*d.*

Report on the Pyinmana Agricultural Station, Burma, for the Year ended March 31, 1931. Pp. 28, $9\frac{3}{4} \times 6\frac{1}{4}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 12 or 1*s.* 1*d.*

Report on the Agricultural Work in the Southern Shan States, Burma, for the Year ending March 31, 1931. Pp. 14, $9\frac{3}{4} \times 6\frac{1}{4}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 12 or 1*s.* 1*d.*

Report on the Tatkon Agricultural Station and Stock Breeding Farm, Burma, for the Year ended March 31, 1931. Pp. 18, $9\frac{3}{4} \times 6\frac{1}{2}$. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Annas 12 or 1*s.* 1*d.*

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1930–31. Pp. 54, $9\frac{3}{4} \times 6$. (Madras: Superintendent, Government Press, 1931.) Price 1 rupee 2 annas.

Report of the Mysore Agricultural Department for the Year ending June 30, 1930. Parts I and II. With the Government Review thereon. Pp. 161, $13\frac{1}{4} \times 8\frac{1}{4}$. (Mysore: Department of Agriculture, 1931.)

Report on the Operations of the Department of Agriculture, Punjab, for the Year ending June 30, 1931. Part I. Pp. 58, $9\frac{3}{4} \times 6\frac{1}{4}$. (Lahore: Superintendent, Government Printing, 1931.) Price Re. 1–4–0 or 1*s.* 11*d.*

Annual Report of the Department of Agriculture, Kenya, for 1930. Pp. 246, $9\frac{1}{2} \times 6$. (Nairobi: Government Printer, 1931.) Price 5*s.*

Annual Report of the Department of Agriculture, S.S. & F.M.S., for the Year 1930. Pp. 31, $13 \times 8\frac{1}{4}$. Supplement to the *F.M.S. Government Gazette*, July 17, 1931.

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Progress (1932, **26**, 474–485). After a brief historical account of the occurrence of insect in stored products, the article deals with the insects usually found, their classification, occurrence, damage done and suggested control.

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Insecticides et Anticryptogamiques. By J. Dufrénoy. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 825–831; 904–916; 978–990). A summary of recent progress in the use of insecticides and fungicides.

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Wine Making. By C. J. Theron. *Bull. No.* 96, *Dept. Agric., Un. of S. Africa.* Pp. 88, 9½ × 6. (Pretoria: Government Printer, 1931.) A full account of the pressing of grapes, the fermentation of the must and the preparation and storage of different types of wine.

Sur un Nouveau Procédé de Vinification pour les Pays Chauds. By M. G. Chevalier. *Agric. Prat. des Pays Chauds* (1932, **3**, 15–21). Description of a method of wine-making suitable for tropical countries.

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Factors Influencing the Keeping Qualities of Pears in Cool Storage. By R. Sutherland. *New Zealand Journ. Agric.* (1931, **43**, 273–276).

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propagation, cultivating, manuring and care of the plant and also harvesting.

Soft Rot (Water Blister) of Pineapples. By J. H. Simmonds. *Queensland Agric. Journ.* (1931, **36**, 394–398). Description of the disease caused by the fungus *Thielaviopsis paradoxa*, and methods of control.

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The Botanical Source and Constituents of Capsicum. By H. S. Redgrove. *Pharm. Journ.* (1932, **74**, 47–48).

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Ginger Cultivation in the Kandy District. By W. Molegode. *Trop. Agric. Ceylon* (1931, **77**, 336–339). Deals with the cultivation, preparation and cost of production of ginger.

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Fodders and Forage Plants

Miscellaneous Information Relating to Breeding of Herbage Plants. *Bull. No.* 1, *Imp. Bur. Plant Genetics (Herbage).* Pp. 22, 9¾ × 7¼. (Aberystwyth, Wales: Imperial Bureau of Plant Genetics, 1930.) Contains notes on the progress in the breeding of herbage plants and extracts from recent literature.

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Mineral Composition of the Fodders of Central Provinces and Berar and Its Bearing on Animal Nutrition. By A. R. Padmanabha Aiyer and R. N. Kayasth. *Agriculture and Live Stock in India* (1931, **1,** 526–532).

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Rhodes Grass. By J. J. Morris. *Farming in S. Africa* (1931, **6,** 428; 432). Description of this drought-resistant pasture grass, its propagation, feeding value and cost of establishment.

Further Notes on the Economic Possibilities of Rice Grass (*Spartina Townsendii*). I.—Plantings in Holland. II.—Plantings in Essex. By F. W. Oliver. *Journ. Min. Agric.* (1931, **38,** 798–805). Supplements the information given in the articles appearing in the *Journal* for December 1928 and January 1929.

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Culture de la Luzerne en Espagne. By F. M. Munoz Palao. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11,** 935–939).

Der Luzerneanbau in Arizona. By J. C. T. Uphof. *Tropenpflanzer* (1932, **35,** 1–9). Account of the cultivation and use of lucerne in Arizona.

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The Lime and Phosphoric Acid Content of Lucerne, as Influenced by the Application of Superphosphate. By A. A. Ramsay and E. L. Griffiths. *Agric. Gaz., N.S. Wales* (1931, **42,** 855–863).

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Veld Grass Silage. A Feature in Rhodesian Pasture Management. By H. G. Mundy. *Rhodesia Agric. Journ.* (1931, **28,** 1077–1088). An account of the making of silage from local grasses.

The Relative Values of Oats, Beet-Molasses, Pulp and Dried Sugar-Beet Pulp for the Fattening of Store Cattle. By H. E. Woodman, W. S. Mansfield and F. H. Garner. *Journ. Min. Agric.* (1932, **38,** 985–993).

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A Preliminary Report on the Poisonous Effects of Bitter Rubber Weed (*Actinea odorata*) on Sheep. By A. B. Clawson. *Journ. Agric. Res.* (1931, **43,** 693–701).

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Poisoning of Sheep by Quinine Bush or Bitter Bark (*Alstonia constricta*). By H. M. Copeland and H. R. Seddon. *Agric. Gaz., N.S. Wales* (1931, **42,** 925–926).

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Sarcostemma australe (Caustic Vine): a Plant that is Poisonous to Stock. By J. A. Gilruth and D. Murnane. *Journ. Counc. Sci. Indust. Res., Australia* (1931, **4,** 225–231). Deals with experiments which have proved that the plant is poisonous to sheep, cattle and horses, as well as certain small laboratory animals. An account is given of the symptoms and post-mortem findings and tests on the toxicity of extracts of the plant.

The Poisonous Action of Ingested Saponins. By A. J. Ewart. *Bull. No.* 50, *Counc. Sci. Indust. Res., Australia.* Pp. 28, 9½ × 6. (Melbourne: Government Printer, 1931.) A detailed investigation of the toxic action of saponins and saponin-containing plants on guinea-pigs, etc., with special reference to certain obscure diseases of stock met with in various parts of the world. The plants considered include *Atalaya hemiglauca*, *Solidago* spp., *Aster Parryi*, and *Senecio Jacobaea.*

Oils and Oil Seeds

Composition of the Seed Fats of *Allanblackia Stuhlmannii*, *Pentadesma butyracea* (Shea), and *Vateria indica* (Dhupa). By T. P. Hilditch and S. A. Saletore. *Journ. Soc. Chem. Indust.* (1931, **50,** 468T–472T).

Chemical Composition of Avocado Seed. By Le Roy S. Weatherby and D. Glenn Sorber. *Indust. Eng. Chem.* (1931, **23,** 1421–1423).

Recherche d'un Denaturant pour les Matières Grasses Employées en Chocolaterie comme Succédanés du Beurre de Cacao. By M. Pichard. *Bull. Office Inter. des Fabricants de Chocolat et de Cacao* (1931, **1,** 199–203). Description of a process for denaturing fats used as substitutes for cacao butter.

China's Production of Castor Seed. *Chinese Econ. Bull.* (1931, **19,** 307–310).

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Pig-Keeping Costs. A Report of an Investigation. *Bull. No.* 33, *Min. Agric. and Fisheries.* Pp. 26, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1931.) Price 6*d.*

Poultry Management. By E. van Manen. *Bull. No.* 93, *Dept. Agric., S. Africa.* Pp. 57, $9\frac{1}{2} \times 6$. (Pretoria: Government Printer, 1931.) Price 3*d.* Contains advice regarding starting poultry farming, suitable breeds, methods of housing, care of poultry and feeding.

Some Diseases of Poultry. *Bull. No.* 6, *Min. Agric. and Fisheries.* Pp. 50, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1931.) Price 8*d.*

The Processing and Handling of Frozen Fish, as Exemplified by Ice Fillets. By A. G. Huntsman. *Bull. No. XX, Biological Board, Canada.* Pp. 52, $9\frac{3}{4} \times 6\frac{3}{4}$. (Ottawa: King's Printer, 1931.)

A Bibliography of Papers on the Physical Properties of Leather. By C. H. Spiers. *Journ. Inter. Soc. Leather Trades Chemists* (1931, **15**, 550–558). A list of 164 references.

Leather Industry and Trade of Germany. By J. Schnitzer. *Trade Information Bull. No.* 744, *U.S. Dept. Commerce.* Pp. 42, $9 \times 5\frac{3}{4}$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 10 cents.

The Deterioration of Vegetable-Tanned Leather on Storage. IV.—Observations on Conditions of Storage and the Rotting of Leather by Artificial Means. By R. F. Innes. *Journ. Intern. Soc. Leather Trades Chemists* (1931, **15**, 481–494).

The Water Permeability of Leather. By R. S. Edwards. *Journ. Intern. Soc. Leather Trades Chemists* (1931, **15,** 495–514).

Forestry

General

Forestry in the Empire During the Last Hundred Years. By Sir A. Rodger. *Empire For. Journ.* (1931, **10,** 203–208).

Programme of Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia. Pp. 69, 10 × 8. Mimeographed copy.

The Functions of the Division of Forest Products. *Trade Circ. No.* 4, *Div. For. Products, Counc. Sci. Indust. Res., Australia.* Pp. 10, 9½ × 6. (Melbourne: Government Printer, 1931.)

Report on the Operations of the Forests Department, Western Australia, for the Year ended June 30, 1931. Pp. 21, 13 × 8¼. (Perth: Government Printer, 1931.)

Report on the Forest Department, British Guiana, for the Year 1930. Pp. 7, 13 × 8¼. (Georgetown, Demerara: Government Printers, 1931.)

L'Exploitation Forestière au Cameroun. By P. Foury. *Agric. Prat. des Pays Chauds* (1931, **2,** 928–939).

Report of the Director of Forestry, Department of the Interior, Canada, for 1929-30. Pp. 62, 9¾ × 6½. (Ottawa: King's Printer, 1931.)

Administration Report of the Conservator of Forests, Ceylon, for 1930. Pp. 18, 9¾ × 6. (Colombo: Government Record Office, 1931.) Price 20 cents.

The Cyprus Forests and Forest Department. By A. H. Unwin. *Empire For. Journ.* (1931, **10,** 218–224).

Report on Forest Administration, Federated Malay States, for the Year 1930. Pp. 65, 13¼ × 8¼. (Kuala Lumpur: Government Press, 1931.) Supplement to the *F.M.S. Government Gazette,* July 3, 1931.

Report on the Forestry Department, Gold Coast Colony, for the Year 1930–31. Pp. 15, 13 × 8¼. (Accra: Government Printing Office, 1931.) Price 2*s.*

Progress Report of Forest Administration in the Province of Assam for the Year 1930–31. Pp. 57, 13¼ × 8¼. (Shillong: Government Press, 1931.) Price Rs. 2–3 or 3*s.* 4*d.*

Annual Report on Working Plans, Silviculture and Entomology in Burma for the Year 1930–31. Pp. 73, 9¾ × 7½. (Rangoon: Superintendent, Government Printing and Stationery, Burma, 1931.) Price Rs. 2 = 3*s.*

Forest Soil and Vegetation in the Hlaing Forest Circle, Burma. *Burma For. Bull. No.* 25, *Ecology Series No.* 1. Pp. 95, 13½ × 8¼. (Rangoon: Superintendent, Government Printing and Stationery, 1931.)

Progress Report on Forest Administration in the Jammu and Kashmir State for the Year ending October 16, 1930. Pp. 47, 10 × 7. (Srinagar: Kashmir Mercantile Press, 1931.)

The Forests of Kashmir. By H. L. Wright. *Empire For. Journ.* (1931, **10,** 182–189). Description of the forests of Kashmir and an account of the work of the Forest Department.

Progress Report on Forest Administration in the Punjab for the Year 1930–31. Pp. 126, 10 × 7. (Lahore: Superintendent Government Printing, 1931.) Price Rs. 4.00 or 6*s.*

Annual Report on the Forest Administration of Nigeria for the Year 1930. Pp. 39, 13 × 8¼. (Lagos: C.M.S. Bookshop, 1931.) Price 3*s.* 6*d.*

Afforestation in Northern Rhodesia. By D. Stevenson. *First Annual Bull., Dept. Agric., N. Rhodesia,* 1931. Pp. 53–55. An account of the introduced trees which seem to offer the best prospects of success in N. Rhodesia.

The Tenth Annual Report of the Forestry Department, Tanganyika Territory, 1930. Pp. 13, 13 × 8¼. (Dar es Salaam: Government Printer, 1931.) Price Shs. 2/50.

Forest Trees of Trinidad and Tobago with Special Reference to Their Timbers. *Leaf. No.* 4, *For. Dept., Trinidad and Tobago.* Pp. 43, 8 × 5¼. (Trinidad: Government Printing Office, 1931.) Price 6*d.*

The Relation of Forest Composition and Rate of Growth to Certain Soil Characters. By H. W. Hicock, M. F. Morgan, H. J. Lutz, H. Bull and H. A. Lunt. *Bull.* 330, *Connecticut Agric. Exper. Sta.* Pp. 74, 9 × 6. (New Haven: Agricultural Experiment Station, 1931.)

Artificial Reseeding on Western Mountain Range Lands. By C. L. Forsling and W. A. Dayton. *Circ. No.* 178, *U.S. Dept. Agric.* Pp. 48, 9¼ × 5⅞. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 15 cents.

Some Observations on Bamboos. By K. L. Khama. *Ind. Journ. Agric. Sci.* (1931, **1**, 473–479). Observations on the flowering of bamboos, on bamboo seeds, mode of underground branching, root systems and bamboo rhizomes.

Notes on Iroko (*Chlorophora excelsa*). By E. H. B. Boulton and T. J. Price. *Trop. Woods* (1931, No. 28, 4–7). See summary, p. 56.

Note on *Chlorophora excelsa* in the Gold Coast. By C. Vigne. *Trop. Woods* (1931, No. 28, 7–10). See summary, p. 56.

Yellow Cedar (*Cupressus* (*Chamaecyparis*) *nootkatensis*). By J. Kay. *Empire For. Journ.* (1931, **10**, 215–217). Description of the tree, its habitat and its timber.

Brazilian Kingwood (*Dalbergia cearensis*). By S. J. Record. *Trop. Woods* (1931, No. 28, 1–3). A description of the tree, its timber and the anatomy of the wood.

The Properties of Sapele Mahogany, *Entandrophragma septentrionale* A. Chev., *E. cylindricum* Sprague and *E. Candollei* Harms.—Nigeria. Preliminary Tests on Timbers, Investigated under the Auspices of the Empire Timbers Committee. *Project* 22, *Investigation* 4A, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 40, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1931.)

Les Eucalyptus comme Arbres de Reboisement pour les Pays Tropicaux et Subtropicaux. By E. N. de Andrade. *Rev. Bot. Appl. et d'Agric. Trop.* (1931, **11**, 416–423; 563–569; 672–681; 741–757; 838–845).

Cultuuraanleg van de Djati (*Tectona grandis* L.) By J. van Roosendael. *Tectona* (1931, **24**, 954–983). A very full account of the propagation and cultivation of teak.

The Control of Diseases and Weeds in a Forest Nursery. By A. E. Muskett. *Journ. Min. Agric., N. Ireland* (1931, **3**, 102–115). A summary of the work carried out in Northern Ireland on the subject.

Insect Pests and Fungus Diseases of Basket Willows. *Bull. No.* 29, *Min. Agric. and Fisheries.* Pp. 14, 9½ × 6. (London: H.M. Stationery Office, 1931.) Price 6*d.*

The European Pine Shoot Moth. A Potential Enemy of Pines in Connecticut. By R. B. Friend. *Circ.* 80, *Connecticut Agric. Exper. Sta.* Pp. 6, 9 × 6. (New Haven: Agricultural Experiment Station, 1931.) Deals with the life cycle and habits of the insect and its control.

The Phoracantha Beetle. By F. G. C. Tooke. *Farming in S. Africa* (1931, **6**, 417–418; 430). An account of this pest of eucalyptus trees, the damage caused and methods of control.

Crown Rot of Juglans in California. By C. O. Smith and J. T.

Barrett. *Journ. Agric. Res.* (1931, **43,** 885–904). Cause, symptoms and control of the disease.

Timbers

Some Characteristics of Home-Grown Timbers. By C. J. Chaplin, J. Latham and F. H. Armstrong. *Bull. No.* 12, *For. Prod. Res., Dept. Sci. Indust. Res.* Pp. 11 + 34 figs., 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) Price 2*s*. The aim of the publication is to show by means of diagrams the comparative significance of the mechanical and physical properties of eight home-grown hardwoods, and of five home-grown softwoods, and to explain the different classes of stress and their application.

The Timber of Home-Grown Douglas Fir (*Pseudotsuga taxifolia* Brit.). *Bull. No.* 10, *For. Products Res., Dept. Sci. Indust. Res.* Pp. 45, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) Price 3*s*.

Some Important Native Timbers. By D. Stevenson. *First Annual Bull., Dept. Agric., N. Rhodesia,* 1931. Pp. 43–52. Gives brief descriptions, together with the native names of forty of the more important native timber trees of Northern Rhodesia. Notes on the uses of the timbers are also given.

British Empire Hardwoods from the Point of View of Turnery. By A. L. Hetherington. *Empire Marketing Board Publication.* Pp. 34, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.)

On Insect Damage to the Timber of Teak (*Tectona grandis*). By D. J. Atkinson. *Burma For. Bull. No.* 26. Pp. 13 + xii Plates, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.)

Dry Rot in Buildings. Recognition, Prevention and Cure. *Leaf. No.* 6, *For. Products Res., Dept. Sci. Indust. Res.* Pp. 5, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) See summary, p. 55.

Preservation of Indian Timbers—the Open Tank Process. By F. J. Popham. *Ind. For. Bull. No.* 75, *Econ. Series.* Pp. 12, 9¾ × 7¼. (Calcutta: Government Central Publication Branch, 1931.) Price Annas 10 or 1*s*.

Summary of Results of Treated Experimental Sleepers Laid in the Various Railway Systems of India, brought up to date. By F. J. Popham. *Ind. For. Bull. No.* 74, *Econ. Series.* Pp. 30, 9¾ × 7¼. (Calcutta: Government of India Central Publication Branch, 1931.) Price Annas 8 or 10*d*.

Wood Impregnation with Water Soluble Salts. By E. H. Wolman and Pflug. *Chem. Age* (1931, **25,** 189). Summary of recent progress on the subject.

Vacuum Kilns. *Trade Circ. No.* 5, *Div. For. Products, Counc. Sci. Indust. Res., Australia.* Pp. 7, 9½ × 6. (Melbourne: Government Printer, 1931.) Description and use of vacuum kilns for timber drying.

Report on an Experiment on Air-Seasoning of Native Timbers. By R. L. Brooks. *Leaf. No.* 3, *For. Dept., Trinidad and Tobago.* Pp. 21, 8 × 5½. (Trinidad: Government Printing Office, 1931.)

Contribution à l'Étude Analytique de Quelques Bois Coloniaux. By P. Marmasse. Pp. 71, 9½ × 6¼. (Paris: Comité National des Bois Coloniaux, Association Colonies-Sciences, 1931.) Price 10 Francs. A study of the chemical composition of some French Colonial timbers.

The Relation between Durability and the Extractives of the Cypress Pines (*Callitris* spp.). By I. W. Dadswell and H. E. Dadswell. *Journ. Counc. Sci. Indust. Res., Australia* (1931, **4,** 208–216).

The Deterioration of Structures in Sea-Water. Twelfth (Interim) Report of the Committee of the Institution of Civil Engineers. Pp. 27, 9½ × 6. (London: H.M. Stationery Office, 1931.) Price 6*d*.

Gums and Resins

Gomme e Resine delle Zona di Oddur. By R. Guidotti. *Rev. Ital. delle Essenze e Profumi* (1931, **13**, 228–233). An account of gums and resins in Italian Somaliland.

Report on the Kauri Gum Industry, New Zealand, for the Year ended March 31, 1931. Pp. 3, 13 × 8½. (Wellington: Government Printer, 1931.) Price 3*d.*

A Practical Manual of Lac Cultivation. By P. M. Glover. *Publication of the Indian Lac Association for Research.* Pp. 81 + 23 figs., 10 × 7½. (Ranchi, Bihar and Orissa: Indian Lac Research Institute, 1931.)

Comparison of Physical Characteristics of French and American Commercial Pine Gum, Rosin and Turpentine. By A. R. Hitch. *Indust. Eng. Chem.* (1931, **23**, 1135–1136).

Improvement in the Production of Oleoresin through Lower Chipping. By E. Gerry. *Tech. Bull. No.* 262, *U.S. Dept. Agric.* Pp. 24, 9¼ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 15 cents.

The Manufacture of Moulded Buttons. By H. E. Crocker. *British Plastics* (1932, **3**, 348–354).

Tanning Materials

Seed Selection of Black Wattle (*Acacia mollissima*). By J. B. Osborn. *Empire For. Journ.* (1931, **10**, 190–202). Studies in the variation in the black wattle and a description of experiments in breeding.

Les Principaux Insectes Nuisibles aux Plantes Productrices de Tanin à Madagascar. By C. Frappa. *Agron. Col.* (1931, **20**, No. 166, 97–98; No. 167, 129–135).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

MODERN INDIA: A CO-OPERATIVE SURVEY. Edited by Sir John Cumming, K.C.I.E., C.S.I. Pp. vi + 304, 7¼ × 5, with map. (Oxford: The University Press; London: Humphrey Milford, 1931.) Price 3*s.* 6*d.*

This is a publication of very great interest at the present time, and it would be difficult to exaggerate its practical value as a concise guide to modern conditions in India. It is to be hoped that no one interested in Indian problems will be deterred from obtaining the volume under the impression that its low price indicates a correspondingly low utility. The book is a symposium, which, in the words of the preface, " sets forth some important elements of the Indian situation by means of a dispassionate presentation

of things as they are, together with some account of the causes which have made them what they are."

The distinguished editor hopes "that *Modern India* will be of service to men of good will who are seeking a path through what often seems to be the impenetrable jungle of Indian controversies." This aim may well be attained if the book is widely studied by those for whom it is intended. Each of its eighteen chapters is contributed by a writer well acquainted with India and having, in the words of the editor, "a peculiar and expert knowledge of his particular subject." One of the most illuminating chapters for readers unfamiliar with Indian conditions will probably be that on "The Country, Peoples, Languages and Creeds"; whilst those on "The India of the Princes," "The Machinery of Government," "Law and Order," "Education," "Irrigation" and "Trade and Industry" may also be mentioned—not to imply that the remaining chapters are any less admirable, but to show that the most vital problems are dealt with in the work.

It would indeed be difficult to gather into so small a compass a fuller and clearer account of the history and present position of India in its more important aspects, and the highest praise is due to all concerned in the compilation and production of the book.

The South and East African Year Book and Guide for 1932. Edited for the Union-Castle Mail Steamship Co., Ltd., by A. Samler Brown, F.R.Met.S., and G. Gordon Brown, F.R.G.S. Pp. lix + 921, $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Sampson Low, Marston & Co., Ltd.) Price 2*s*. 6*d*.

A previous issue of this valuable annual publication was briefly noticed in this Bulletin (1930, **28**, 103). The merely nominal price of 2*s*. 6*d*. charged for the book forms no indication of its degree of usefulness for travellers, business men and others interested in the countries of South and East Africa. As the type is small, though clear, an even larger mass of detail is included than might be gathered from the fact that the volume comprises over 900 pages. Practically every subject likely to be of interest is dealt with, and many readers will find particular value in the sections describing travel routes, which are essentially concise gazetteers for the regions traversed. At the end of the volume there is a series of clearly printed coloured maps, covering over 60 pages and still further enhancing the great utility of the book.

AGRICULTURAL POLICY IN SOUTH AFRICA. By Hubert D. Leppan, Professor of Agricultural Economics, Pretoria University. Pp. 101, $8\frac{1}{2} \times 5\frac{1}{2}$. (Johannesburg: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1931.) Price 6*s*.

This small work is by the author of the treatise on "The Agricultural Development of Arid and Semi-Arid Regions" noticed in this BULLETIN, 1928, **26**, 398. Professor Leppan states that the thesis now presented has formed the basis of his teaching and writings during the last ten or twelve years, and that he has endeavoured to give a background to agrarian policy in South Africa. The book is divided into three parts, viz. "The South African Farming Situation," "Agrarian Policy in South Africa" and "The Lot of the Farmer." It covers a wide range and, if possibly not of special interest outside the Union, should prove useful and suggestive to South African agriculturists.

THE PIONEER FRINGE. By Isaiah Bowman. Pp. ix + 361, $10 \times 6\frac{3}{4}$. (New York: American Geographical Society, 1931.)

The author of this book explains in an introductory note that it has been written in accordance with a "plan of research in pioneer settlement" which he presented some years ago to the National Research Council in the United States. The Council approved the plan and recommended it to the Social Science Research Council, which eventually added its support. The latter body and the National Geographical Society have contributed to a joint fund for the publication of a series of papers, entitled "Pioneer Settlement," by thirty authors who are "specialists in this field and familiar with the regions with which they deal"; and the present work is intended as an introduction to this symposium.

The book, which is excellently arranged and produced, furnishes a readable description of the various modes of pioneering and the development of new regions in America, Asia, Africa and Australia, special attention being paid to the first-named continent. It is a volume likely to be of considerable interest to students and teachers of geography.

REGIONAL SURVEY AND ITS RELATION TO STOCK-TAKING OF THE AGRICULTURAL AND FOREST RESOURCES OF THE BRITISH EMPIRE. By Ray Bourne, M.A. Pp. 169, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: The Clarendon Press, 1931.) Price 15*s*.

The object of the author in writing this book is "to focus the attention of a wide public upon the possibilities

of Regional Survey in relation to the scientific assessment of the Empire's resources." It is pointed out that this subject is a matter of immediate interest not only from the scientific point of view but also to all concerned with the development of the Empire. The thesis is not an easy one to expound, and while " every effort has been made to present the subject in a manner intelligible to all," and " the more technical matter has been put in a simple form," it must be admitted that the book is not easy reading, and that close attention is essential to follow and appreciate the general theme.

The author submits that the determination of the correct methods of stock-taking forms the problem of primary importance in the forests of the British Empire. He considers that the solution does not lie simply in the provision of more staff to carry on existing methods of enquiry, but in the investigation and employment of new methods of assessing local conditions in the forest and agricultural areas.

The author's experience has pointed to the necessity for the most detailed investigations in this connection and shows that the only feasible method lies in a study of vegetation and other characters by means of strip sampling. The plotting of such strips leads to the recognition of " sites," which are areas presenting similar conditions of soil, geology, climate, etc.; and these again extend over " regions " which differ as regards the characters of their constituent sites. The method therefore resolves itself into the familiar " Regional Survey," which has been the subject of much quiet and valuable work by many individuals and societies in this country for many years past. Mr. Bourne points out that the identification of sites as units of locality for purposes of assessment furnishes a practical solution of the problem. The extended mapping of sites presents great difficulties and is a laborious undertaking, but he finds that the problem can be greatly simplified by approaching it from the regional standpoint, and that in the actual work of the Survey requisite for this approach reconnaissance and mapping by means of aircraft is a new factor presenting altogether new facilities.

This is the kernel of the book. In Chapter II the author discusses experimental regional survey and gives a detailed account of the results of air survey by strip samples of a line of country extending from Barford on the Oxfordshire-Gloucestershire boundary to Crowthorne on the Berkshire-Surrey border. The survey was carried out by the Aircraft Operating Company. Closely connected with this chapter is the Appendix, giving a detailed re-

gional description of the ground which is of great interest and shows intensive study of local conditions. The whole forms a model of the type of survey advocated by the author for the countries of the Empire. In Chapter III the need for such a survey is discussed, and the general conclusions of the author are reviewed. Accompanying the book is a set of admirably executed and reproduced photographs of the air survey, with detailed explanations of the plates.

BAILLIÈRE'S ENCYCLOPÆDIA OF SCIENTIFIC AGRICULTURE. Edited by Herbert Hunter, D.Sc. In two volumes. Pp. xvi + 1361, $9\frac{1}{2} \times 6\frac{1}{2}$. (London: Baillière, Tindall & Cox, 1931.) Price 63*s.*

The preparation of an encyclopædia of scientific agriculture is an arduous task, and the editor of these two volumes can be congratulated on having brought together in convenient form a mass of very useful information. The list of some eighty contributors, many of whom have a world-wide reputation, is sufficient guarantee of the accuracy and the value of the sections with which they deal.

Whilst the agriculture of the British Isles is the main concern of the book, much of the contents is generally applicable to other temperate countries, particularly as special attention has been given to elucidating the principles which underlie agricultural practice.

In several respects the work lacks the anticipated encyclopædic character, and, as the editor states he will greatly welcome suggestions for the improvement of future editions, some omissions may be mentioned. Thus in the preface it is pointed out that the units of the Empire are mutually dependent and " for this reason a survey of each of the different countries is included together with a brief account of the lines which developments may be expected to follow in the future." Some 133 pages are devoted to such general articles on agriculture in the British Isles, all the Dominions, India and the West Indies. But there are no accounts of the agriculture in such important areas of the Empire as East and West Africa, Ceylon, Fiji, Mauritius, Palestine, etc.

The treatment of various groups of plant products is also curiously selective. Thus whilst there is a good up-to-date account of cocoa, there is no reference to tea or coffee. Amongst fibres, flax and cotton are dealt with, but not hemp or jute, although there is an account of sisal. The fruits produced in Great Britain are adequately treated,

also bananas, whilst all the citrus group (oranges, grape fruit, limes, etc.) and the pineapple are ignored. Similarly there is no reference to tobacco.

On the animal side, whilst cattle are only dealt with more or less incidentally under dairying, horses merely referred to in relation to the competition of tractors, and sheep and swine mentioned only by short references under "feeding," there is an excellent general article of some forty pages on poultry. Such defects do not detract from the great value of the wealth of information which is given, but serve to indicate that the work is not of so encyclopædic a character as one might expect from its title.

Modern Milling of Sugar Cane. By Francis Maxwell, D.Sc., M.I.Mech.E., F.C.S. Pp. 423, 10 × 7½. (London: Norman Rodger, 1932.) Price 50s.

The reputation of Dr. Maxwell as a sugar technologist of world-wide experience is so thoroughly established that this book will be at once accepted as an authoritative work on the subject of "the design, construction, installation, operation, practice and control covering the milling stations of modern cane-sugar factories in the principal sugar-cane countries."

After a preliminary chapter on milling, the author treats in detail all the main items in the machinery of a milling station, e.g. cane unloaders and carriers, milling units and accessories, maceration and diffusion plants, pumps, strainers, etc. In a final chapter Dr. Maxwell discusses on broad lines certain fundamental questions, one of the most important being the relation between milling efficiency and capacity. This is governed by many variable factors, and local conditions usually determine which course is the more economical. Thus in Hawaii the highest point of efficiency is reached with comparatively low rates of crushing. In Cuba, on the other hand, capacity has, until recently, been the prime consideration. Suggestions are offered whereby in some cases economic improvements can be effected in raising extraction whilst maintaining capacity. After dealing with other questions of practical importance Dr. Maxwell in conclusion expresses the hope that "this book will aid the sugar engineer to form an unbiassed judgment not only as to the plant and layout best suited for a new factory in a given situation, but also as to how best to modify and modernise existing plant."

The clarity and practical nature of the text, and the numerous and excellent illustrations and diagrams combine

to render this book indispensable not only to the sugar engineer, but to all concerned in the economical running of sugar-cane factories.

LE RICIN: BOTANIQUE, CULTURE, INDUSTRIE ET COMMERCE. By Ph. Eberhardt. Pp. 136, 10 × 6½. Third edition. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1931.) Price 20 francs.

The author mentions that the first edition of this book appeared at a time when castor oil found practically no industrial applications apart from medicinal use and soap-making. To-day the employment of the oil as a lubricant, especially for aircraft engines, has increased the demand for castor seed and the book has therefore been entirely revised and brought up to date. The author points out that the world is practically dependent on British India for supplies of castor seed and that it is most desirable for French interests to develop the cultivation in French overseas possessions, which he states are well suited to the crop. He instances Indo-China, already possessing a growing industry in castor, as an example of a country in which the cultivation should be encouraged, and mentions Syria, Tunis, Senegal, Dahomey and the southern Zone of Morocco as having good prospects for castor seed production. Madagascar and French Guiana are also worth consideration.

The book is written on straightforward lines and gives a good account of the subject. Historical and botanical chapters are followed by an illustrated account of the varieties of castor seed, and the chapter on cultivation includes a general description of field methods and an account of the industry in British India and in the French Colonies. The section dealing with the industrial application of castor gives analyses of the seed and oil, a description of the methods of oil extraction, and an account of the uses of the oil. The book concludes with a short study of the commerce in castor.

THE COCONUT. By Edwin Bingham Copeland. Third edition. Pp. xviii + 233, 8½ × 5½. (London: Macmillan & Co., Ltd., 1931.) Price 20*s*.

The preparation of the third edition of this standard work has not involved any extensive revision, but the text has been brought up to date in a number of matters. The account of bud rot has been revised and includes a

discussion of the work of Johnston and Rorer in the West Indies associating *Bacillus coli* with the disease. Additions are also made to the chapter on the selection and treatment of seed, bringing forward the results of recent statistical studies in Malaya and the Philippines demonstrating the value of the selection of nuts in planting out. There are also additions to the chapter on field culture.

The discussion of the general position of the coconut industry contained in the foreword is the most important new feature of the book. The author mentions that the study of coconut culture in the Philippines, and the prompt application of the results of the investigations have brought the Philippine industry " from a mere bad example " to the position of the greatest and most profitable in the world, paying to the workers the highest maintained wages known in tropical agriculture. In other countries—Malaya, Dutch East Indies and Ceylon—researches have also been carried on, and it is now becoming possible to compare cultural practices, yields and costs obtaining in the different coconut-growing countries, though, at present, the author considers that available information is not sufficiently reliable to warrant his presenting a chapter undertaking an effective comparison of the industry in the chief producing lands. Such a comparison, he believes, should be possible within the next ten years.

It is pointed out that the previous edition of the book was prepared during a period of great prosperity, and that the present issue comes at a time of world-wide depression, specially severe in primary industries. He suggests, however, that the relative stability of the coconut industry in this crisis should be gratifying to those engaged in it. Coconuts, he states, are one of the few great crops yielding at any rate some profit in a period of acute economic depression.

Some expansion of the industry has been due to advances in oil technology which have provided a market for increasing supplies of the oil ; but the author suggests that, conceivably, the next technical advance will be the production of a competing article from a cheaper oil, and he considers that the hostility of dairy interests also may possibly bring about artificial restrictions on the use of coconut oil. He therefore sounds a warning that the very measure of the achieved success of the coconut industry entails some danger to its future. [This question is discussed fully in the book on *Margarine as a Butter Substitute*, by K. Snodgrass, dealt with on the next page.]

MARGARINE AS A BUTTER SUBSTITUTE. By Katharine Snodgrass. Pp. xiv + 333, $8\frac{3}{4} \times 5\frac{3}{4}$. (California: Food Research Institute, Stanford University; London: P. S. King & Son, Ltd., 1930.) Price 12*s.*

This book, which is No. 4 in a series of Fats and Oils Studies published by the Food Research Institute, Stanford University, California, gives a detailed study of the significance of the competition between margarine and butter which has taken place and still exists, particularly in the United States of America. The book is divided into three parts. The first is devoted to an account of the legislation which has been passed with a view to controlling the manufacture of margarine. Although relevant laws of other countries are touched upon, the greater part of this section is concerned with America. The purpose of the American laws is twofold, viz. to safeguard the dairy industry and to ensure the purity of the margarine. By far the greater number of these regulations have been made with the first object in view, thereby indicating the keen nature of the competition that exists between the two industries. Details are given of both Federal and State legislation. It is interesting to note that most of the margarine sold in the United States is uncoloured, since there is a tax of 10 cents per lb. on margarine which has been artificially coloured to imitate butter, this tax having been imposed in the interests of the dairy industry.

In the second part of the book will be found a brief résumé of the developments in the manufacture of margarine which have taken place in the sixty years which have elapsed since 1870, when Mège-Mouriez during the Franco-Prussian War won the prize offered by Napoleon III for a butter substitute. Among the changes that have been made are mentioned the discontinuation of the use of stomach and udder extracts; the partial or complete replacements of animal fats by vegetable oils and fats, especially coconut oil; the use of milk "ripened" by inoculation with pure cultures of bacteria to impart a butter flavour; the improvement of the texture by chilling the warm emulsion of fat and milk with a spray of cold water or by means of revolving drums chilled with ice-cold brine; the use of hydrogenated fats, and the addition of various substances to facilitate emulsification. The last chapter of this part is devoted to a comparative study of the nutritive value of butter and margarine. Special emphasis is laid upon the amount of vitamins present in these fats, especially vitamins A and D, and mention is made of the steps taken by manufacturers to increase the amount of these substances in margarine.

The last part of the book contains an economic analysis of the margarine industry. Statistics are given showing the rate of consumption of margarine in Europe and America. The organisation of the butter and margarine industries is discussed and the relation between the markets for these two products is described. In the final chapter the case for the imposition of a higher tax on the imported fats used in margarine is discussed, and the opinion is expressed that the extent of the advantages accruing to the dairy industry through the raising of the duties on these raw materials is problematical. It is also stated that, although the butter industry may suffer some losses through the competition of the allied industry, it should not be seriously embarrassed thereby as long as it is efficiently conducted.

In Appendixes to the volume are copies of the Federal Acts of 1886 and 1902 and a summary of State legislation, together with statistical tables relating to the production and consumption in the United States of butter and margarine and the amounts of materials used in the manufacture of the latter.

The book is well written and gives a comprehensive account of the margarine industry in the United States and of its relation to the butter industry.

BAUMWOLLE. By Professor Dr. G. Kränzlin and Dr. A. Marcus. Wohltmann-Bücher Monographien zur Landwirtschaft warmer Länder, Band 9. Pp. viii + 169, 7 × 5. (Berlin: Deutscher Auslandverlag Walter Bangert, 1931.) Price RM. 6.

This little work deals in a concise but practical manner with cotton and its production. After a brief description of the plant, its principal species and varieties and its geographical distribution, reference is made to its climatic and soil requirements and the application of manures. Consideration is given to the selection and preparation of the seed for sowing and the preliminary treatment of the land. Information is supplied on all phases of the cultivation of the crop, including irrigation and harvesting and the control of pests and diseases. The methods of ginning and delintering are also described.

The book concludes with some statistics of the world's production, consumption and prices of cotton, and a list of a few of the more important works of reference and periodical publications on the subject. It can be recommended as a useful and handy guide for those actually engaged in cotton-growing, and also as a valuable source

of information for all who may be interested in the production of this important fibre.

SISAL UND ANDERE AGAVEFASERN. By Professor Dr. Fr. Tobler. Wohltmann-Bücher Monographien zur Landwirtschaft warmer Länder, Band 10. Pp. vi + 104, 7 × 5. (Berlin: Deutscher Auslandverlag Walter Bangert, 1931.) Price RM. 5.

This work gives a brief general survey of Sisal, together with reference to other agave fibres, including Cantala, Maguey, Henequen, Zapupe and Ixtle. The character and distribution of the fibre agaves are dealt with; information is given regarding the microscopical and other properties of the fibre, and the fibre content of the leaves is discussed. A useful account is supplied of the cultivation of the agaves, including methods of propagation, the influence of the soil and climate on their growth, their manurial requirements, and the diseases and pests by which they are liable to be attacked. Particulars are furnished of the methods of laying out the plantations in different countries and the length of life of the plants. The cutting of the leaves and the extraction of the fibre are considered and a good description is given of the so-called decorticating machinery; in this connection it is observed that although full information is afforded regarding the machines made by Krupp of Magdeburg and Haake of Berlin, no mention is made of those manufactured by Robey of Lincoln which are widely employed in East Africa. The drying, brushing and baling of sisal are dealt with, reference is made to the spinning of the fibre, and a short list of publications on the agave fibres is appended.

It is interesting to note that the author expresses the opinion that chemical examination is of no value for comparing the quality of fibres. In fact, he ventures to state that the publication of analyses of sisal is entirely useless both to the producer and the user of the fibre. In this connection it may be pointed out that few experts with long experience in the chemistry of fibres would agree with this view.

On the whole, the book is a useful compilation, and should prove of much value to all interested in the production and utilisation of sisal and other agave fibres.

THE PREPARATION AND SPINNING OF FLAX FIBRE. By S. A. G. Caldwell. Pp. x + 364, 8¾ × 5½. (London and Manchester: Emmott & Co., Ltd., 1931.) Price 15s.

This book is based on a series of articles contributed by the author to the pages of the *Textile Manufacturer*, and

is written throughout with the object of presenting the subject from a modern standpoint.

The first chapter is devoted to an account of the flax plant and its cultivation, the preparation of the fibre, the characters of the flax produced in different countries, and the marketing of the crops. The remainder of the work deals with the various operations carried out in the course of flax-spinning, including flax-dressing, the preparation of the line and the tow for spinning, and the processes of dry spinning, wet spinning and reeling. Information is also given regarding the upkeep and repairing of the preparing and spinning machinery, and on wood turning and fluting for the manufacture of pressing rollers and of roving and spinning bobbins. The final chapter is concerned with the estimation of quantities, production and costs in flax-spinning mills.

The book is written in a practical manner, is well illustrated, and should prove very useful to the textile student and also to all engaged in the flax-spinning industry.

Wool Quality. A Study of the Influence of Various Contributory Factors, their Significance and the Technique of their Measurement. By S. G. Barker, Ph.D., D.I.C., Director of Research, Wool Industries Research Association. Pp. 333, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: His Majesty's Stationery Office, 1931.) Price *21s.*

Although manufacturers of woollens and worsteds are able to form a fairly accurate opinion of the quality of different wools and their suitability for particular purposes, no definite scientific standards of quality have been established. For this reason, the author and his colleagues of the Wool Industries Research Association have made a prolonged study of the various properties of wool which contribute to the so-called "quality," and have been aided in the work by a grant from the Empire Marketing Board, under whose auspices the present volume is published.

The influence of biological, chemical and physical factors on the characters and manufacturing properties of wool is discussed from both technological and scientific standpoints.

After considering the question of wool grease and the methods of scouring the fleece, reference is made to wool sorting and its commercial aspects. The different factors on which quality depends are then dealt with as follows:

(1) The dimensional or geometrical attributes of the fibre, their manufacturing significance and measurement.

This section gives a historical review of the methods of determining these constants, and subsequently describes in detail the modern methods of measuring density, fineness, length, crimp, contour and scaliness.

(2) The internal physical structure of the fibre and its nature, origin and growth, and response to processing. In this connection attention is devoted to the structure of the wool fibre and its investigation in polarised light, by X-ray analysis and by ultra-microscopy. The properties of elasticity, swelling and resilience, and the electrical conductivity and magnetic susceptibility are also considered.

(3) The chemical constitution of the fibre, or fibre substance, and its relationship to production and manufacture.

The book contains a large number of excellent illustrations and a useful bibliography, and, as pointed out in the Preface written by the Right Hon. J. H. Thomas, " it will become a standard treatise for technologists, scientific workers and students in every part of the Empire, and will act as a stimulus to a better understanding of one of the Empire's greatest raw materials."

INSECT PESTS OF FARM, GARDEN AND ORCHARD. By E. Dwight Sanderson, Ph.D. Third edition, revised and enlarged by Leonard Marion Peairs, Ph.D. Pp. vii + 568, 9 × 6. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) Price 31*s*.

The appearance of a third edition of this standard work is very welcome. Although it deals primarily with the insect pests of the United States, there are few countries in which agriculturists and horticulturists will not find in it information of practical value. Modern means of transport, whilst resulting in great advantages to man, have also facilitated insect travel, and in spite of vigorous quarantine restrictions, insect pests have a disconcerting tendency to become more widely distributed.

The volume deals with the general principles of insect control: cultural, biological, chemical, etc., methods and apparatus. Successive chapters are then devoted to the pests of specific crops and products, e.g. grains, legumes, cotton, tobacco, sugar cane, fruits of all kinds, stored products. There are also chapters on insects attacking live-stock, poultry and man.

The wide range of the book, the sound and practical character of its information, and the number and excellence

of its illustrations, should result in the maintenance of its position as a valuable work of reference.

IMPROVEMENT OF WOODLANDS. By W. E. Hiley, M.A. Pp. viii + 250, $7\frac{3}{4} \times 5\frac{1}{2}$. (London: Country Life, Ltd., 1931.) Price 10*s.* 6*d.*

This attractively bound book is one of the most important publications on the commercial management of British woodlands that has appeared. It was written with the author's conviction—shared by many competent observers—that the prosperity and productiveness of the countryside can be increased by the better use of woodlands, and perusal of the volume suggests that the evidence brought forward amply confirms his views. In a previous work on Economics in Forestry, Mr. Hiley made a scientific study of forest management from the financial aspect; in the present book he has utilised the results of that investigation in a more popular form with a view to inducing landowners and others responsible for woodlands to take a more professional interest in their use and management. The book is also adapted to the needs of those who are not practical foresters but desire to understand the problems which confront owners of woodlands and the methods by which these problems are solved.

The recent setting up of an official Committee, under the chairmanship of Sir Roy Robinson, to consider the better utilisation of home-grown timber suggests that the book has appeared at an appropriate time. The successful marketing of woodland produce depends largely upon the proper understanding of management, and a reliable guide to the principles of such knowledge will be a boon to those anxious to avail themselves of opportunities offered.

Mr. Hiley's chapters are well arranged. The opening series deal with economics of the question, namely, the present state of British woodlands and forest taxation set off by Government grants. Cultural subjects are considered in relation to choice of tree species (coniferous and broad-leaved) for planting, the maintenance of the estate nursery, the establishment of plantations and subsequent sylvicultural operations. The question as to when tree crops are to be considered mature and ready for harvesting is discussed, together with methods of marketing, measurement of timber and operating estate saw-mills. This section of the book is rounded off with a chapter on the general scheme of management, working plans and mapping. It is perhaps characteristic of British woodcraft

that the volume should contain an interesting chapter on "How to combine Sport with Forestry," by the Hon. N. A. Orde-Powlett. The book is closely (but very clearly) printed and contains a large amount of most valuable information. It should be in the hands of all those possessing woodlands even of the smallest area.

SEEDING AND PLANTING IN THE PRACTICE OF FORESTRY. By James W. Toumey, M.A., F.D., Sc.D. Second edition, revised and enlarged by Clarence F. Korstian, M.F., M.A., Ph.D. Pp. xviii + 507, 9 × 6. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) Price 25*s*.

Some years before Professor Toumey wrote the first edition of this book, published in 1916 (this BULLETIN, 1917, **15**, 294), he had organised the work in seeding and planting for the United States Forest Service. That book served its purpose in providing a guide to such operations under conditions prevailing in North America. During the last sixteen years much new knowledge has been gained with reference to forest nursery and planting practice, and the object of this revised and enlarged edition is to render available this new information.

In the United States, as in so many other countries, there has been enormous reduction in the area under forests. It is estimated that forests there now cover only 470 million acres, compared with 820 millions three centuries ago. The present forest resources should continue for a very long period to meet the real needs of the nation, provided that regeneration goes hand in hand with wise utilisation.

This book deals with all phases of the task of regeneration, and whilst written with special reference to North American conditions, it contains much of interest to foresters all over the world.

Amongst questions of broad interest which are well dealt with may be mentioned the importance of surveys to determine the areas to be planted, the use of native versus exotic trees, the formation of large-scale plantations rather than reliance on natural regeneration, planting in opposition to sowing, pure and mixed stands, etc. There is much information of direct practical value, e.g. on the formation and use of forest nurseries, planting methods, spacing, etc., embodying the results of wide and varied experience. This work, like its predecessor, should be for many years the standard hand-book on the subject with which it deals.

ALCOHOLIC FERMENTATION. By Arthur Harden, Ph.D., D.Sc., LL.D., F.R.S., Emeritus Professor of Biochemistry in the University of London and late Head of the Biochemical Department of the Lister Institute. Fourth edition. Pp. vii + 243, $9\frac{3}{4} \times 6\frac{1}{4}$. (London, New York, Toronto: Longmans, Green & Co., 1932.) Price 15*s*.

The third edition of this book, which is one of the series of "Monographs on Biochemistry," was noticed in this BULLETIN (1923, **21**, 664), where its importance from a technical standpoint was indicated as well as the interesting manner in which the subject is presented. As the author points out in a short preface to the new edition, a great amount of further work has been carried out on alcoholic fermentation since the third edition appeared and it has been impossible to give a complete account of this recent research, but the hope is expressed that nothing of fundamental importance has been overlooked. The volume, which contains a copious bibliography of 37 pages, forms a practical treatise which should be of great utility to the class of readers for whom it is intended.

INTERNATIONAL ADDRESS BOOK OF BOTANISTS. Pp. xv + 605, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Baillière, Tindall & Cox, 1931.) Price 12*s*. 6*d*.

This volume is an outcome of a resolution passed at the Fifth International Botanical Congress, held at Cambridge in 1930, and has been prepared under the supervision of a committee consisting of Professor L. Diels, Director of the Berlin Botanic Gardens, Dr. E. D. Merrill, Director-in-Chief of the New York Botanical Gardens and the late Dr. T. F. Chipp, Assistant Director of the Royal Botanic Gardens, Kew. The arrangement is by countries alphabetically, the entries under each country being, as far as practicable, in the language of the country. There is an index to the countries, in English, French and German, at the beginning, and another to the persons mentioned, at the end of the book. The entries under each country include (1) Societies, with their postal addresses; (2) Institutions wholly or chiefly botanical, with their addresses and departments, and educational institutions having separate departments dealing with botanical teaching and research; and (3) the surname and initials of botanists, both professional and amateur, with information as to their offices and professional qualifications, their postal addresses and their special botanical interests.

The book has obviously been compiled with great care and will prove of much value to botanists who desire to

get into touch with those in other parts of the world who are working on similar lines to themselves.

THE USE OF FERTILISERS IN TROPICAL AND SUB-TROPICAL AGRICULTURE. By A. Jacob, Ph.D., and V. Coyle, M.Sc. Pp. 272, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Ernest Benn Limited, 1931.) Price 10*s.* 6*d.*

Part I of this book is devoted to a simple introductory account of fertilisers and their relation to plant growth and soil conditions with special reference to tropical and sub-tropical crops. Suggestions are made whereby the planter can test for himself the value of various manurial treatments for his own crops and under the conditions of his own estate.

In Part II a summary, accompanied by references to original sources of information, is given of results obtained by the use of fertilisers on a large number of crops. Particulars are given of the yields on manured and unmanured plots, but although an increase in crop is very frequently shown as the result of manuring, no information is given as to whether there was an increased profit, or, in other words, whether from the planter's point of view the manuring was remunerative. The book, which contains a large number of good illustrations, is one from which planters could obtain a good deal of useful information and suggestions for practical tests.

SOIL CONDITIONS AND PLANT GROWTH. By Sir E. John Russell, D.Sc., F.R.S. Pp. viii + 636, $8\frac{1}{2} \times 5\frac{1}{2}$. Sixth edition. (London, New York and Toronto: Longmans, Green & Co., 1932.) Price 21*s.*

Although a period of only five years has elapsed since the publication of the fifth edition of this work, the advances made in all branches of knowledge both directly and indirectly connected with the study of the soil during this time have been so extensive that it has been necessary to enlarge and re-write a very large proportion of the book. Even so, it has been found possible to keep the book of a reasonable length only by a rigorous process of selection from the available material.

The historical introduction necessarily remains the same as before. The next chapter dealing with the soil conditions affecting plant growth has been considerably enlarged and rearranged, the effects of the various factors involved, both singly and in combination, being studied in their relation to the growth of the plant as a whole and to

the growth and composition of the separate portions of the plant.

There has been added to the new edition a concise account of the mode of formation of the main soil types now recognised, such as podsols, chemozens, desert soils, saline soils and laterites, and a very useful summary of the chief principles of agricultural management of the various types.

The book as a whole has been brought thoroughly up-to-date, and is likely to remain a standard work of reference for all soil workers.

HYDROGEN IONS: THEIR DETERMINATION AND IMPORTANCE IN PURE AND INDUSTRIAL CHEMISTRY. By Hubert T. S. Britton, D.Sc., B.Sc., D.I.C., F.I.C. Second edition, thoroughly revised and enlarged. Pp. xvi + 589, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1932.) Price 25*s*.

The general scope and arrangement of this volume follow closely on the lines of the first edition (see this BULLETIN, 1930, **28**, 408). In many of the chapters there are small amplifications and additions, mainly dealing with very recent work, which should add to the book's usefulness. There are also short new chapters on the effect of hydrogen-ion concentration on the precipitation of sulphides and on its importance in the preservation of eggs.

The chief innovation in this edition is a new section (Chapter XI), written by Dr. R. A. Robinson, which aims at providing an adequate discussion of the Lewis and the Debye-Hüchel Theories of Electrolytes, in so far as these theories affect the several factors involved in the study of the activity of hydrogen ions.

The additions and alterations in those sections of the book which deal with the importance of hydrogen-ion concentration in various industrial processes are small and mainly unimportant.

The fact that a new edition of the book should have been required in less than three years from the date of first publication seems to indicate that it has been found to have a considerable measure of usefulness.

COAL, AND THE COALFIELDS IN WALES. By F. J. North, D.Sc., F.G.S. Second edition. Pp. 257, $8\frac{1}{2} \times 5\frac{1}{2}$. (Cardiff: National Museum of Wales, 1931.) Price 4*s*.

This second edition replaces a much smaller book, keeping pace with the great expansion of knowledge on

the subject of coal which has taken place in the interval between the two issues, and illustrated by the fact that the bibliography has been increased from 309 items in the first edition to over 500.

As now constituted, the book is divided into four parts, the first dealing with the constitution and utilisation of coal, research and its practical applications. The second, on the formation of coal and the coalfields, gives a full account of the geological conditions existing prior to the Carboniferous System and how they led to its formation, and those which led to its close. Also the plants and animals of the forests of the Coal Measures.

Part 3 treats specifically on the coalfields of North and South Wales, the different varieties of coal met with in them, methods of coal classification, etc. The fourth part is devoted to the Carboniferous rocks of Wales, other than coal, and their concomitant minerals, including limestone, sandstone, fireclay, iron, lead and zinc ores, iron- and copper-pyrites, millerite, ankerite and hatchettine.

The book is full of information and is excellently illustrated with 28 full-page plates, each generally consisting of a number of single illustrations, mostly photos, and 57 figures, consisting of diagrams, maps, dissected models showing geological structures and drawings of fossil plants. It concludes with a well-set-out index.

SIMPLE DETERMINATIVE MINERALOGY. By H. R. Beringer. Pp. 239, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Mining Publications, Ltd., 1931.) Price 10*s.* 6*d.*

This book, which is primarily intended for the use of students and prospectors, deals with the determination of mineral species by methods readily applicable in the field and without the aid of an elaborately equipped mineralogical laboratory. Many methods have hitherto been adopted for the ready recognition of minerals, but the author, who has had considerable experience in this subject as lecturer in mineralogy at the School of Metalliferous Mining, Cornwall, considers that the most satisfactory method of rapid identification is by means of the two outstanding physical properties of minerals, viz. specific gravity and hardness. The fact that these two properties for any particular mineral species may not be strictly constant, does not, in the opinion of the author, greatly militate against this method of identification, since in the case of doubtful minerals simple confirmatory tests are suggested and useful advice is given on how to avoid possible errors of determination.

The work is divided into five sections, excluding an appendix and two indexes. The first section, consisting of some 13 pages, is devoted to a detailed and illustrated description of the methods employed for the determination of the specific gravities of minerals. This is followed by 27 pages of useful tables in which minerals are grouped in order of their specific gravities and arranged in each group according to their hardness. The next 172 pages, constituting about three-quarters of the text, contain useful observations regarding the chief physical characteristics of minerals arranged in order of their specific gravities; while the remaining sections, representing some 13 pages, consist of an alphabetical list of elements, etc., found in minerals, with methods of their identification.

This book should prove particularly interesting, not only to those for whom it is primarily designed, but also to the systematic mineralogist, who doubtless will appreciate the fairly complete mineralogical tables. These tables, according to the preface, include virtually the whole of the 824 mineral species listed by Dana, with the exceptions of those of which the specific gravities are not known. The omission, however, of such minerals as baddeleyite is obviously an oversight, while the inclusion of various new minerals, recorded from time to time in the *Mineralogical Magazine*, would have rendered the tables even more valuable than they are at present. Nevertheless, the compilation of these tables supplies a long-felt want, and the book should prove useful.

THE MICROSCOPIC CHARACTERS OF ARTIFICIAL INORGANIC SOLID SUBSTANCES OR ARTIFICIAL MINERALS. By Alexander Newton Winchell. With a Chapter on the Universal Stage by Richard Conrad Emmons. Second edition. Pp. xvii + 403, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 31*s*.

This book is a considerably enlarged and carefully revised edition of a work published by the author in 1927 as No. 4 of the University of Wisconsin Studies in Science, and may be regarded as forming a supplement to Part 2 of *Elements of Optical Mineralogy*, previously noted in this BULLETIN (1928, **26**, 131). These two excellent works, including as they do optical data of virtually all minerals, both natural and artificial, that can be identified microscopically, are very valuable additions to the science of Mineralogy and the author is to be congratulated on what is undoubtedly a fine achievement.

The present work is divided into three sections dealing respectively with "Principles and Methods," "Descriptions of Artificial Inorganic Solid Substances" and "Determinative Tables." The first section, which did not appear in the original edition of this book, consists in large measure of selections from Part I (fourth edition) of the author's *Elements of Optical Mineralogy*, reviewed in the preceding number of this BULLETIN (1931, **29**, 503). The second section has been thoroughly revised with many changes and additions, while the third section has been entirely rewritten.

Wherever possible the refractive indices of pure artificial inorganic substances are given to the fourth decimal place in three kinds of light, viz. C, D and F, since it has been found that these characteristics, provided the material is of definite composition and space lattice, may be considered absolutely constant to the fourth or fifth decimal place. The refractive indices of natural minerals, on the other hand, are rarely significant to the third decimal place.

The work is profusely illustrated by some 300 diagrams, sketches and photographs, in addition to five folding plates, four of which are identical with those published in Part I (fourth edition) of the work already mentioned. In view of the fact that the student is referred to this latter work for the study of crystals in convergent polarised light, it seems that the duplications of these plates, together with the incorporation of substantial sections of the text from this work, have added materially and unnecessarily to the cost of the present volume, which is 31s. net. The present work, however, has the merit of being fairly complete in itself, and should prove of considerable value to those investigating the phenomena of artificial mineral formation as a means of elucidating the origin of natural rocks and minerals, a problem which is admittedly one of the most difficult and baffling of geological science.

GEOLOGICAL MAP OF INDIA AND ADJACENT COUNTRIES, on a scale of 1 in. = 32 miles or 1 : 2,027,520, fifth edition, in 8 sheets, published under the direction of the Director of the Geological Survey, India, 1931. Price for the set Rs. 16.

Twenty years have elapsed since the last geological map of India was published, during which time the work of the Geological Survey has been carried on increasingly. Many fresh areas have been surveyed and old areas resurveyed, and the accumulated results of all this careful

mapping have been incorporated in these latest sheets. The new map was prepared under the supervision of Dr. J. Coggin Brown, Dr. L. L. Fermor, Dr. A. M. Heron, Sir E. H. Pascoe and Mr. G. H. Tipper, and heliozincographed at the Survey of India Offices in Calcutta. Each sheet measures about 21 by 38 in., without margins, and the whole when mounted covers an area of about 7 ft. 6 in. by 6 ft. 6 in. Some 27 colours or combinations of colours have been employed in producing the map, which is a fine example of the cartographer's art and represents a marked advance upon any of the previous editions of this very useful map.

German-English Geological Terminology. By Dr. Arnold Cissarz and William R. Jones, D.Sc., D.I.C., F.G.S., M.I.M.M. Pp. xvii + 250, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Thomas Murby & Co.; Leipzig: Max Wex; New York: D. Van Nostrand Co., 1931.) Price 12*s.* 6*d.*

This very unusual kind of book is written for the benefit of English and German students of geology, each of whom requires to obtain a knowledge of the scientific terms employed in the other's language, and the purpose is achieved in rather a novel way. The book takes the form of an elementary descriptive text-book of geology and its related sciences, arranged in the form of a series of definitions designed to introduce the maximum number of technical terms. Each technical word or phrase is italicised on its first introduction into the text, the English text being printed on the left-hand pages with its exact German equivalent opposite on the right-hand pages, the paragraphing and pagination having been carefully arranged to conform to this plan. The book is thus equally useful to students speaking either language, especially as there are both English and German indexes. Besides the ordinary text, there are several appendices which contain abbreviations in frequent use in the two languages, conversion tables of weights and measures, the chemical elements and a glossary of German and English names for the principal minerals.

A good deal of difficulty must have been encountered in compiling such a book, and the construction of sentences is often unusual or even clumsy, but that this is quite unavoidable is realised when it is remembered that the intention is to make the text in the two languages conform as closely as possible.

The scope of the book is comprehensive, covering the terms used in physical geography, structural geology, stratigraphy, crystallography, mineralogy, petrology, palæontology, vulcanism and ore deposits, all, of course,

very briefly, and with the avoidance so far as possible of controversy.

Such a book is much more useful to a student than a mere technical dictionary, although the latter may be more comprehensive, because it enables him to see the words in their appropriate context and thus to appreciate more precisely their significance. It is being published simultaneously in England, Germany and the United States.

BOOKS RECEIVED FOR NOTICE

INDIA AND THE BRITISH. By Patricia Kendall. Pp. x + 467, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Charles Scribner's Sons, 1931.) Price 16*s*.

EXOTIC FOREST TREES IN THE BRITISH EMPIRE. By R. S. Troup, C.I.E., D.Sc., F.R.S. Pp. viii + 259, $9\frac{1}{2} \times 6\frac{1}{4}$. (Oxford: The Clarendon Press, 1932.) Price 20*s*.

SOME EAST AFRICAN CONIFERÆ AND LEGUMINOSÆ. By L. Chalk, M.A., D.Phil., J. Burtt Davy, M.A., Ph.D., and H. E. Desch, B.Sc., M.A. Pp. 68, $9\frac{1}{2} \times 6$. (Oxford: The Clarendon Press, 1932.) Price 5*s*.

GROWTH AND THE DEVELOPMENT OF MUTTON QUALITIES IN THE SHEEP. A Survey of the Problems Involved in Meat Production. By John Hammond, M.A., with a section in conjunction with A. B. Appleton, M.A., M.B. Pp. xxvi + 597, $9\frac{3}{4} \times 6\frac{1}{4}$. (Edinburgh and London: Oliver and Boyd, 1932.) Price 42*s*.

INTRODUCTION TO AGRICULTURAL BIOCHEMISTRY. By R. Adams Dutcher and Dennis E. Haley. Pp. x + 484, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 28*s*.

DIZIONARIO DI MERCEOLOGIA E DI CHIMICA APPLICATA. By Professor Dr. G. Vittorio Villavecchia, in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi and Dr. R. Belasio. Fifth edition. Vol. IV. (Senapa-Zucchero.) Pp. 747, 10×7. (Milan: Ulrico Hoepli, 1932.) Price L. 80.

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EDUCATION FOR EMPIRE SETTLEMENT. By Alex. G. Scholes, B.A. (Melb.), Dip.Ed. (Melb.), Ph.D. (Edin.). Pp. xii + 250, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Longmans, Green & Co., Ltd., 1932.) Price 7*s*. 6*d*.

INTERNATIONAL INSTITUTE OF AFRICAN LANGUAGES AND CULTURES. MEMORANDUM IX. A FIVE-YEAR PLAN OF RESEARCH. Pp. 14, $9\frac{3}{4} \times 6\frac{3}{4}$. (London: International Institute of African Languages and Cultures; Oxford University Press, 1932.) Price 1*s*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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EMPIRE FIBRES FOR MARINE CORDAGE

Sisal Hemp and New Zealand Hemp

Report on Rope Tests (Fourth Series)

In previous issues of this Bulletin (1927, **25**, 359; 1931, **29**, 1) reports have been published of three series of trials conducted by the Imperial Institute under the auspices of its Advisory Committee on Vegetable Fibres with the object of determining whether Sisal hemp and New Zealand hemp are sufficiently resistant to the action of sea-water to enable them to compete with Manila hemp for the manufacture of ropes for marine purposes.

A fourth series of trials has now been completed, the results of which form the subject of the present report. It will be observed that they confirm those of the previous series and demonstrate that ropes made of East African Sisal and New Zealand hemp when exposed to sea-water are capable of retaining their strength to a similar extent to Manila ropes.

The tests were carried out with samples of 3-in. ropes, made according to the late Mr. E. J. W. Buckpitt's specification from the following fibres :

Rope No.	Fibre of which composed.
1	East African Sisal No. 1, Brushed.
2	East African Sisal No. 1, Unbrushe
3	Java Sisal.
4	Manila S.3.
5	Manila K.
6	Manila M.1.
7	New Zealand Fair.

As in the earlier series of trials, the ropes were exposed to the action of sea-water by placing them in wooden

crates fixed to Southend Pier, in such a position as to ensure that during each tide they were completely submerged for a period and completely uncovered for a period.

The experiments were commenced in March 1931.

In order that the ropes might be in the same condition in the tensile tests with regard to humidity, all the test pieces were thoroughly washed with fresh water and tested in an air-dry condition.

The determination of the breaking strains of the ropes was made by means of a Riehlé machine, the method of attachment being by grips.

The results obtained are given in the following tables and are represented graphically in the accompanying chart.

BREAKING STRAIN OF THE ROPES BEFORE IMMERSION

—	Sisal.			Manila.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Unbrushed.	Java.	S.3.	K.	M.1.	Fair.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	8,610	9,320	10,130	11,830	11,230	10,460	9,530
„ 2 . .	9,270	9,300	10,100	11,240	11,000	10,760	9,240
„ 3 . .	9,120	9,880	10,350	11,680	10,890	10,550	9,470
„ 4 . .	9,000	9,640	9,830	11,590	10,660	9,840	9,210
„ 5 . .	9,170	9,340	9,860	11,380	11,670	10,980	9,340
„ 6 . .	9,040	9,740	11,210	11,260	11,670	10,010	9,030
Maximum .	9,270	9,880	11,210	11,830	11,670	10,980	9,530
Minimum .	8,610	9,300	9,830	11,240	10,660	9,840	9,030
Variation .	660	580	1,380	590	1,010	1,140	500
Average .	9,035	9,537	10,247	11,497	11,187	10,433	9,303

BREAKING STRAIN AFTER 2 MONTHS' IMMERSION IN SEA-WATER (MARCH 16 TO MAY 11)

—	Sisal.			Manila.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Unbrushed.	Java.	S.3.	K.	M.1.	Fair.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	6,640	7,010	8,180	9,770	8,960	9,160	8,980
„ 2 . .	6,850	7,270	7,320	11,470	9,000	9,810	6,850
„ 3 . .	7,370	6,620	7,800	11,540	9,180	9,230	7,920
„ 4 . .	7,750	6,240	8,220	11,080	8,960	9,450	8,370
„ 5 . .	7,180	7,590	7,820	10,040	9,840	8,660	8,430
„ 6 . .	6,850	8,100	7,180	9,500	9,320	9,280	6,800
Maximum .	7,750	8,100	8,220	11,540	9,840	9,810	8,980
Minimum .	6,640	6,240	7,180	9,500	8,960	8,660	6,800
Variation .	1,110	1,860	1,040	2,040	880	1,150	2,180
Average .	7,107	7,138	7,753	10,567	9,210	9,265	7,892

BREAKING STRAIN AFTER 4 MONTHS' IMMERSION IN SEA-WATER (MARCH 16 TO JULY 14)

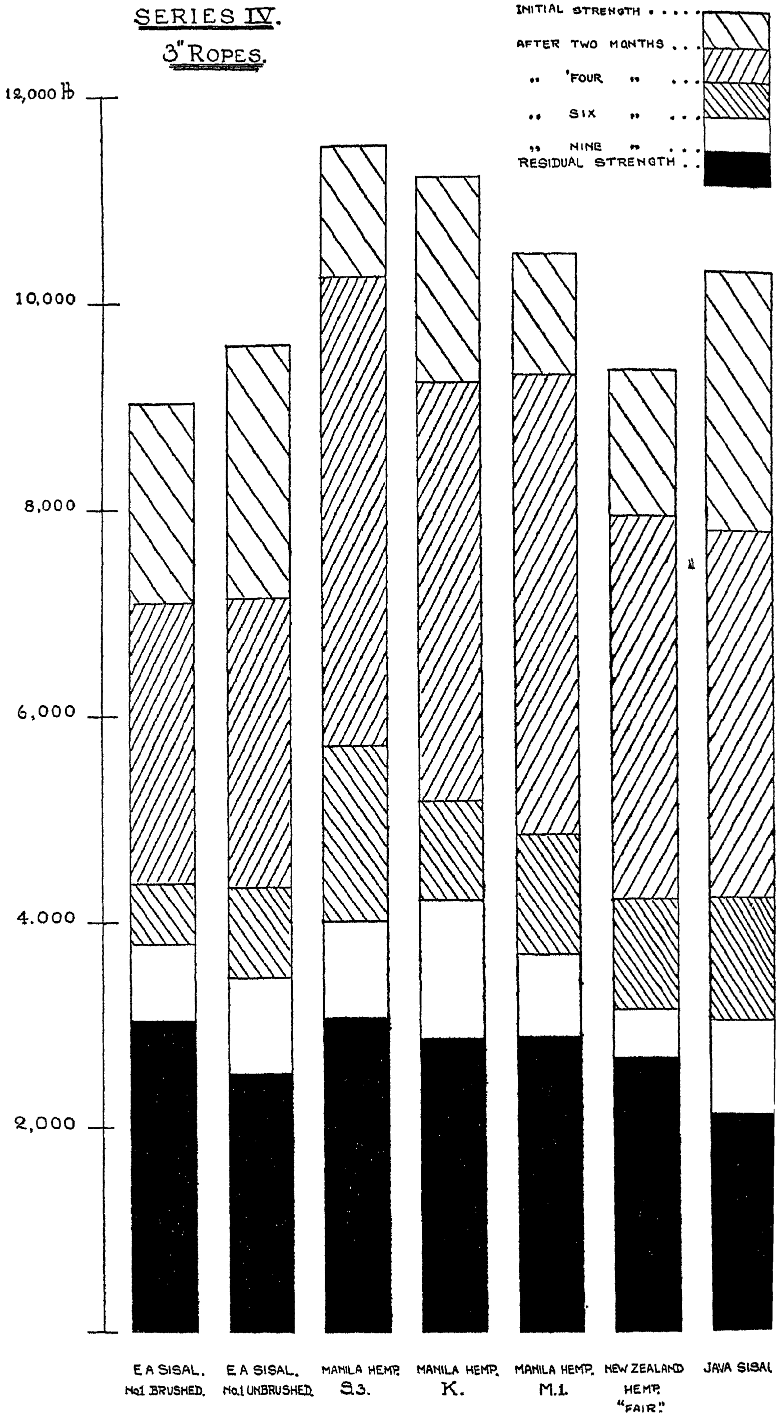
	Sisal.			Manila.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Unbrushed.	Java.	S 3.	K.	M 1.	Fair.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 .	4,000	5,260	4,000	5,610	5,160	4,960	4,050
„ 2 .	4,650	4,360	3,770	5,910	4,760	5,520	4,480
„ 3 .	4,570	3,430	4,350	5,580	5,850	5,160	4,400
„ 4 .	3,700	5,080	4,450	5,430	5,230	4,330	4,000
„ 5 .	4,520	4,030	4,260	5,700	4,750	4,460	4,000
„ 6 .	4,820	3,810	4,430	6,000	5,200	4,620	4,250
Maximum	4,820	5,260	4,450	6,000	5,850	5,520	4,480
Minimum	3,700	3,430	3,770	5,430	4,750	4,330	4,000
Variation	1,120	1,830	680	570	1,100	1,190	480
Average	4,377	4,328	4,210	5,705	5,158	4,842	4,197

BREAKING STRAIN AFTER 6 MONTHS' IMMERSION IN SEA-WATER (MARCH 16 TO SEPTEMBER 17)

—	Sisal.			Manila.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Unbrushed.	Java.	S.3.	K.	M.1.	Fair.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	4,680	2,930	2,490	3,970	3,680	3,790	2,790
„ 2 . .	3,340	4,040	3,450	4,150	4,760	3,910	3,270
„ 3 . .	3,620	3,310	2,710	3,540	3,790	3,500	3,180
„ 4 . .	4,030	2,870	2,670	3,680	3,610	3,670	3,160
„ 5 . .	3,620	3,870	3,440	5,120	4,940	3,640	3,390
„ 6 . .	3,360	3,700	3,410	3,590	4,360	3,560	3,050
Maximum .	4,680	4,040	3,450	5,120	4,940	3,910	3,390
Minimum .	3,340	2,870	2,490	3,540	3,610	3,500	2,790
Variation .	1,340	1,170	960	1,580	1,330	410	600
Average .	3,775	3,453	3,028	4,008	4,190	3,678	3,140

BREAKING STRAIN AFTER 9 MONTHS' IMMERSION IN SEA-WATER (MARCH 16 TO DECEMBER 16)

—	Sisal.			Manila.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Unbrushed.	Java.	S.3.	K.	M.1.	Fair.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	3,040	2,740	2,580	3,280	2,850	3,150	2,870
„ 2 . .	2,910	2,670	2,050	3,090	2,980	2,970	2,610
„ 3 . .	2,970	2,230	2,290	3,170	2,780	2,630	2,500
„ 4 . .	3,020	2,730	1,740	2,800	2,720	2,700	2,800
„ 5 . .	3,260	2,200	1,790	3,000	2,940	2,730	2,600
„ 6 . .	3,050	2,490	2,250	3,080	2,850	3,000	2,610
Maximum .	3,260	2,740	2,580	3,280	2,980	3,150	2,870
Minimum .	2,910	2,200	1,740	2,800	2,720	2,630	2,500
Variation .	350	540	840	480	260	520	370
Average .	3,042	2,510	2,117	3,070	2,853	2,863	2,665


SERIES IV.
3" ROPES.
INITIAL STRENGTH
AFTER TWO MONTHS
" FOUR "
" SIX "
" NINE "
RESIDUAL STRENGTH
12,000 lb
10,000
8,000
6,000
4,000
2,000
E A SISAL. No.1 BRUSHED.
E A SISAL. No.1 UNBRUSHED.
MANILA HEMP S.3.
MANILA HEMP K.
MANILA HEMP M.1.
NEW ZEALAND HEMP "FAIR."
JAVA SISAL

Summary

In the following tables are given the average strength (in lb.) of each rope before immersion, the average strength after each period of immersion, and the loss of strength expressed as a percentage of the original average strength of the rope.

—	Sisal Hemp.			Manila Hemp.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed	African No. 1 Un-brushed.	Java.	S.3.	K.	M 1.	Fair.
Original average strength . lb.	9,035	9,537	10,247	11,497	11,187	10,433	9,303
Period of immersion, 2 months (Mar. 16–May 11):							
Average strength lb.	7,107	7,138	7,753	10,567	9,210	9,265	7,892
Percentage loss .	21·3	25·2	24·3	8·1	17·7	11·2	15·2
Period of immersion 4 months (Mar. 16–July 14):							
Average strength lb.	4,377	4,328	4,210	5,705	5,158	4,842	4,197
Percentage loss .	51·6	54·6	58·9	50·4	53·9	53·6	54·9
Period of immersion, 6 months (Mar. 16–Sept. 17):							
Average strength lb.	3,775	3,453	3,028	4,008	4,190	3,678	3,140
Percentage loss .	58·2	63·8	70·5	65·1	62·5	64·7	66·2
Period of immersion, 9 months (Mar. 16–Dec. 16):							
Average strength lb.	3,042	2,510	2,117	3,070	2,853	2,863	2,665
Percentage loss .	66·3	73·7	79·3	73·3	74·5	72·6	71·4

In the following table the percentage decreases in average strength shown by each rope are collected together for convenience of comparison.

Months.	Sisal Hemp.			Manila Hemp.			New Zealand Hemp.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
	African No. 1 Brushed.	African No. 1 Un-brushed.	Java.	S.3.	K.	M.1.	Fair.
2 (Mar. 16–May 11) .	21·3	25·2	24·3	8·1	17·7	11·2	15·2
4 (Mar. 16–July 14) .	51·6	54·6	58·9	50·4	53·9	53·6	54·9
6 (Mar. 16–Sept. 17) .	58·2	63·8	70·5	65·1	62·5	64·7	66·2
9 (Mar. 16–Dec. 16) .	66·3	73·7	79·3	73·3	74·5	72·6	71·4

Remarks

The Manila ropes used in this series of trials had greater initial strength than the Sisal ropes, whereas in previous series the opposite was generally the case. After two months' exposure to sea-water the Sisal ropes had undergone greater reduction of strength than the Manila ropes, but subsequently the rate of deterioration of the Manila ropes increased much more rapidly than that of the Sisal ropes, so that at the end of 4 months the average percentage loss of the East African Sisal ropes was 53·1 and that of the Manila ropes 52·6 ; at the end of six months the average percentage losses were 61·0 for the Sisal and 64·1 for the Manila, and at the end of nine months 70·0 and 73·5 respectively.

It is of interest to note that at the conclusion of the nine months' exposure the No. 1 Brushed Sisal rope had a greater strength than the K. and M.1. Manila ropes, and was of almost exactly the same strength as the S.3 rope, while its percentage loss of strength was considerably less than that of any of the Manila ropes. Thus, whereas in respect of the three previous series of trials the advantage on the whole lay with the Manila, in the present series the advantage is rather with the Sisal. As stated in the earlier report, however, such differences are probably not sufficient to be of practical importance.

The New Zealand hemp rope behaved very similarly to the Manila ropes and at the end of the nine months' exposure had suffered a percentage loss of strength of 71·4 as compared with an average loss of 73·5 for the Manila ropes and of 70·0 for the Sisal ropes.

With regard to the Java Sisal rope it will be observed that it had a greater initial strength than either of the East African Sisal ropes but suffered a somewhat more rapid loss on exposure to sea-water, and after six months had become weaker than any of the other six ropes tested.

In publishing this report the Imperial Institute Advisory Committee on Vegetable Fibres again desire to record their indebtedness to the Pier Committee of the Corporation of Southend-on-Sea for their valuable assistance in providing the necessary facilities for the immersion of the ropes.

THE IMPROVEMENT OF FIJI COPRA

COCONUTS are one of the main crops in the Fiji Islands and large quantities of copra are exported every year, the amount in 1930 being 23,882 tons valued at £369,524. Fiji copra, however, is of inferior quality with the result that it commands a comparatively low price. With a view to obtaining higher prices, methods for securing the production of a better product have been discussed during recent years by the authorities. The introduction of a scheme of compulsory grading and inspection of copra intended for export is still under consideration and the Director of Agriculture has made certain proposals in this connection (*Fiji Agric. Journ.*, 1931, No. 2, p. 71). The main points of this suggestion are that :

" Legal power should be taken either by amendment of the existing Ordinance or by the introduction of a new Bill to empower the Governor by Proclamation to require copra exported from any port or part of the Colony to be inspected, graded and branded prior to shipment. Provision would require to be made for the appointment of Inspectors, the establishment of grades, the manner of inspection, the marking or branding of bags containing copra which had been inspected and graded, the making of regulations and penalties for breach of the Ordinance and regulations.

" It would be desirable in the first instance to confine export copra inspection and grading to the port of Suva, where the work would be under constant and close supervision. After a period, say, one year, the system could be extended to Levuka and to other points of export from the Colony.

" The scheme could be financed by an export tax on copra."

Steps are also being taken by the Department of Agriculture to improve the quality by the adoption of more careful methods of preparation and are described in *Fiji Agricultural Journal* (1931, Vol. 4, No. 3). The poor quality of Fiji copra is due to the large proportion of very low-grade material it contains. This inferior copra is mainly produced by natives using primitive methods from

nuts grown on palms which have received no cultivation. The nuts used are usually old and in many cases have germinated. During the drying of the copra in most cases no steps are taken to protect the nuts from rain, with the result that the material becomes mouldy and rapidly deteriorates. With some natives it is also customary to sell green copra (i.e. pieces of undried nuts) or to mix it with properly cured copra. In either case sweating occurs and a product of poor quality results.

In order to demonstrate whether an improved copra could be obtained by employing methods other than those in general use in Fiji, the Department of Agriculture made the following series of experiments, and samples of the copra thus produced were forwarded in August 1930 to the Imperial Institute for examination and commercial valuation.

General Details of Experiments

Sulphuring Chamber.—As some Fiji planters already sulphur their copra with beneficial results and in other countries sulphuring has been used with good results for some years, it was decided to try this method for native copra. For this purpose a portable sulphuring chamber, having a capacity of 1,000–1,500 nuts (equivalent to about 5 cwt. of dry copra) was used. It was so designed that it could be made locally ; dismantled and assembled quickly ; and could be readily carried by natives from place to place. The internal dimensions of the chamber were 6 ft. 6 in. long, 4 ft. 6 in. high, and 3 ft. 4 in. wide. Seven trays with bottoms of wire-netting were used to hold the nuts. At the bottom of the chamber was placed the burner for the sulphur. This consisted of an enamelled fry-pan with an enamelled plate fixed 9 in. above it to prevent the flames reaching the bottom tray. Flowers of sulphur mixed with fibre from the coconut husks were burned.

Nuts used.—The nuts used in all the experiments were representative of those used by the natives. They were obtained from native plantations in the Lower Rewa district near Suva. A considerable proportion of the nuts used were old ones.

In experiments 1, 2 and 7, germinated nuts were also tested, the object being to show what difference, if any, there was between the quality of the copra made from ripe nuts and that made from germinated nuts.

Treatment of Nuts.—In experiments 1 and 2 the nuts were husked and halved before sulphuring and in the remainder the green copra was cut out plantation style, in smaller pieces, fingers, etc. For the subsequent curing of the meat, after sulphuring, old banana packing tables were used on which the green copra was spread. These tables did not allow of a free circulation of air as do the usual reeded ratas (shelves) commonly used in Fiji.

Control Samples.—As controls for all experiments, 100 nuts were cut out according to the method adopted for the various experiments but were not sulphured. They were spread out on a table to sun-dry in the usual way, being placed under cover at night and protected from the weather.

Climatic Conditions.—The season (January to March, 1930) during which the experiments were carried out was the wet or rainy season when drying conditions were not favourable for good copra curing. On 67 days rain fell and the humidity during the three months varied from 68 to 100 per cent. The average time taken for drying was from 9 to 19 days, the average being 14 days. Under dry-season conditions the usual time in most parts of the Islands is from 2½ to 5 days.

Description of Experiments.—Four series of experiments were carried out; in the first three the green copra was sulphured without previous treatment, while in the fourth the nuts were given a preliminary treatment.

Series I.—Both ungerminated and germinated nuts were exposed to the fumes of 4 oz. of sulphur for

(*a*) 6 hours (experiment 1)
(*b*) 3 „ („ 2)

In each experiment sulphured ungerminated nuts were dried: (1) without protection from the weather and without being covered at night, (2) with protection from weather and at night. The sulphured germinated nuts were treated as (2).

In experiment 1 the copra took 12 days to dry. Moulds

appeared on the third day and continued to increase until the ninth day, the growths appearing more persistent and more freely on the sulphured samples than on the unsulphured control. In the other experiment the time required for drying was 10 days and moulds appeared on the fourth day.

Series II.—In this series ungerminated nuts were exposed to the fumes of 8 oz. of sulphur for

(*a*) 3 hours (experiment 3)
(*b*) 6 ,, (,, 4)
(*c*) 9 ,, (,, 5)

After sulphuring, part was dried without protection and the remainder with protection from the weather and at night.

In experiment 3 the copra took 12 days to dry and moulds appeared on the third day. In experiment 4 the drying time was 11 days and moulds appeared on the fourth day, but did not increase. In experiment 5, 15 days were required for complete drying; moulds appeared on the control sample on the third day and on the sulphured copra on the fifth day, but in both cases the development was so slow that on the fifteenth day of drying the mould was not particularly marked.

The results of the experiments in this series indicate that sulphuring of green copra may have some value since in experiment 5 particularly the quality of the sulphured covered copra was slightly better than that of the control.

Series III.—Green copra was exposed to the fumes of 12 oz. of sulphur for

(*a*) 3 hours (experiment 6).
(*b*) 6 ,, (,, 7).
(*c*) 9 ,, (experiments 8 and 8*a*).
(*d*) 4½ ,, (experiment 11).

In experiment 6 some moulds appeared on the control on the fourth day of drying, but in the case of the sulphured samples no moulds were apparent until the copra was dry (17 days). Although the weather was unfavourable during the drying, the sulphured covered copra remained very white and dried of excellent appearance.

In experiment 7 germinated nuts were treated in addition to ungerminated ones. Fifteen days were required

for curing in this experiment, moulds appearing on the control on the fourth day but not on the sulphured copra.

Experiment 8*a* was a duplication of No. 8 as the latter was not considered satisfactory. Moulds developed freely on the control sample from the fourth day onwards while the sulphured covered remained practically free from moulds during the whole period of drying (16 days).

As in the previous experiments of this series there was practically no visible difference in the quality of the copra produced by various periods of sulphuring (i.e. 3, 6 and 9 hours), green copra was exposed in experiment 11 for $4\frac{1}{2}$ hours to determine whether a shorter period than 6 hours would be as effective and thus save time. The sulphured covered copra took 17 days to dry and was of first-grade quality.

This series of experiments, judging from the appearance alone, definitely favours the practice of sulphuring.

Series IV.—In these experiments the green copra was first washed in a suitable medium before being sulphured and sun-dried.

It had been repeatedly noticed throughout the previous experiments that during the drying process the copra often turned brown at the edges. This is a common complaint amongst planters with both sun-dried or kiln-dried copra. As this defect does not appear to be due to the action of moulds, it was suggested that the cause was that the small amount of sugar deposited on the meat as the milk dried became caramelised by the heat of the sun or kiln. To prevent the depositing of the sugar, experiments were carried out in which the green copra was given a preliminary washing before being dried. In experiments 9 and 12 sea-water was used; in Nos. 10 and 13 a solution of potassium metabisulphite; in Nos. 14 and 14*a* sodium carbonate solution; and in Nos. 15 and 15*a* a solution of caustic soda.

Experiments 9 *and* 12.—In these experiments green copra was washed in sea-water before drying. A second washing was given in experiment 12. Sea-water was used as it is generally recognised that copra dried on the beach where it is subject to the direct sea breezes and spray is invariably of good quality and also because copra which

has been immersed in sea-water is usually of good appearance and quality after being sun-dried. In experiment 9 part of the treated copra was dried unprotected from weather and at night. The remainder received the necessary protection. The quality of both lots was very poor. Moulds developed freely from the third day onwards and gave the copra a very poor and dirty appearance. This defect was due to the high atmospheric humidity which prolonged the period of drying to 17 days. The result obtained in Experiment No. 12 was similar.

Experiments 10 *and* 13.—A saturated solution of potassium metabisulphite was used in these experiments. This chemical was chosen as it was thought that not only would the sugar be removed but the solution of metabisulphite on drying would decompose and automatically form a fungicidal film over the copra. In experiment 10 the green copra was sprayed with 60 c.c. of the solution and in No. 13 with 100 c.c. In both experiments the copra developed moulds freely and the final products were of bad quality. It is evident from these results that the particular chemical used did not on drying automatically sulphur the copra.

Experiments 14 *and* 14*a*; 15 *and* 15*a*.—In these experiments the green copra was washed in

(*a*) A 10 per cent. solution of sodium carbonate (Experiment 14).
(*b*) A 5 per cent. solution of sodium carbonate (Experiment 14*a*).
(*c*) A 5 per cent. solution of caustic soda (Experiment 15).
(*d*) A $2\frac{1}{2}$ per cent. solution of caustic soda (Experiment 15*a*).

It was noted that in each case after being washed the colouring matter of the brown testa of the nuts spread across the white meat, discolouring it, and the discoloration persisted in the dried copra, giving it a rather dark appearance. Some of the green copra in each experiment, while still wet with the washing solution, was exposed to the fumes of 12 ounces of sulphur for 6 hours before being dried. In these cases the sulphur dioxide exercised a bleaching effect on the copra; the discoloration caused by the alkaline solution was removed; the meat became

whiter than usual and the copra retained this whiteness on drying. It was also noted that no moulds appeared on the sulphured samples and no injurious insects were present, although copra beetles were found in the unsulphured samples.

Chemical Examination of Samples

The samples prepared in the experiments described above were forwarded by the Director of Agriculture to the Imperial Institute for chemical examination and commercial valuation. The results of the chemical examination are given in the following tables. In explanation of the terms used it may be stated that:

(*a*) *Control copra* means the green copra, sun-dried, protected from rain and placed under cover at night until cured.

(*b*) *Sulphured copra* means green copra which has been subjected to the fumes of burning sulphur for the periods stated, then sun-dried, protected from rain and placed under cover at night until cured.

(*c*) *Sulphured copra, uncovered,* differs from (*b*) in that it received no protection from rain and was left uncovered at night.

(*d*) *Sulphured vara copra* differs from (*b*) in that the copra used was that obtained from germinated nuts.

Series I.	Moisture.	Oil in copra as received.	Oil in moisture-free copra.	Acid value of extracted oil.	Free fatty acids (expressed as lauric acid).
	per cent.	*per cent.*	*per cent.*		*per cent.*
Experiment 1. "4 oz. of sulphur were burnt in the chamber, which was sealed for 6 hours."					
(*a*) Control. Unsulphured. Sun-dried	4·2	67·3	70·3	12·7	4·53
(*b*) Sulphured. Covered	3·9	68·4	71·2	8·3	2·96
(*c*) Sulphured. Uncovered	3·9	68·6	71·4	9·5	3·39
(*d*) Sulphured Vara. Covered	3·8	68·3	71·0	12·1	4·32
Experiment 2. "4 oz. of sulphur were burnt in the chamber, which was sealed for 3 hours."					
(*a*) Control. Unsulphured. Sun-dried	3·7	68·0	70·6	7·0	2·50
(*b*) Sulphured. Covered	3·6	69·0	71·6	10·9	3·89
(*c*) Sulphured. Uncovered	4·0	67·8	70·6	22·9	8·18
(*d*) Sulphured Vara. Covered	4·2	68·1	71·1	15·5	5·53

	Moisture. *per cent.*	Oil in copra as received. *per cent.*	Oil in moisture-free copra. *per cent.*	Acid value of extracted oil.	Free fatty acids (expressed as lauric acid). *per cent.*
SERIES II. *Experiment* 3.					
"8 oz. of sulphur were burnt in the chamber, which was sealed for 3 hours."					
(*a*) Control. Unsulphured. Sun-dried . .	4·1	67·4	70·3	6·4	2·29
(*b*) Sulphured. Covered .	3·8	67·8	70·5	7·4	2·64
(*c*) Sulphured. Uncovered	3·6	70·8	73·4	16·8	6·00
Experiment 4.					
"8 oz. of sulphur were burnt in the chamber, which was sealed for 6 hours."					
(*a*) Control. Unsulphured. Sun-dried . .	3·4	69·8	72·3	8·2	2·93
(*b*) Sulphured. Covered .	3·8	68·7	71·4	7·3	2·61
(*c*) Sulphured. Uncovered	3·5	71·0	73·6	23·6	8·43
Experiment 5.					
"8 oz. of sulphur were burnt in the chamber, which was sealed for 9 hours."					
(*a*) Control. Unsulphured	3·7	69·1	71·8	7·9	2·82
(*b*) Sulphured. Covered .	3·7	68·8	71·5	7·8	2·78
(*c*) Sulphured. Uncovered	3·2	71·2	73·6	21·5	7·68
SERIES III. *Experiment* 6.					
"12 oz. of sulphur were burnt in the chamber, which was sealed for 3 hours."					
(*a*) Control. Unsulphured	3·6	69·7	72·3	7·1	2·53
(*b*) Sulphured. Covered .	3·8	69·0	71·7	4·4	1·57
(*c*) Sulphured. Uncovered	3·4	71·4	73·9	23·5	8·39
Experiment 7.					
"12 oz. of sulphur were burnt in the chamber, which was sealed for 6 hours."					
(*a*) Control. Unsulphured	3·6	68·9	71·5	5·4	1·93
(*b*) Sulphured. Covered .	3·5	69·0	71·5	4·5	1·61
(*c*) Sulphured. Uncovered	3·5	70·8	73·4	22·9	8·18
(*d*) Sulphured Vara. Covered . . .	3·4	70·7	73.2	8·1	2·89

SERIES III.—*cont.*	Moisture.	Oil in copra as received.	Oil in moisture-free copra.	Acid value of extracted oil.	Free fatty acids (expressed as lauric acid).
Experiment 8.	*per cent.*	*per cent.*	*per cent.*		*per cent.*
"12 oz. of sulphur were burnt in the chamber, which was sealed for 9 hours."					
(*a*) Control. Unsulphured	3·9	68·2	71·0	13·6	4·86
(*b*) Sulphured. Covered .	4·0	66·9	69·7	9·6	3·43
(*c*) Sulphured. Uncovered	3·5	72·6	75·2	57·8	20·63
Experiment 8*a*.					
Same treatment as in Experiment 8.					
(*a*) Control to 8*a*, 9, 10 and 11. Unsulphured .	4·0	68·7	71·6	20·1	7·18
(*b*) Sulphured. Covered .	3·7	67·9	70·5	4·2	1·50
Experiment 11.					
"12 oz. of sulphur were burnt in the chamber, which was sealed for 4½ hours."					
(*a*) Sulphured. Covered .	4·1	66·8	69·7	11·2	4·00
SERIES IV.					
Experiment 9.					
"Washed in sea-water."					
(*a*) Sea-water. Once washed. Covered . .	3·6	68·5	71·1	11·7	4·18
(*b*) Sea-water. Once washed. Uncovered .	3·5	70·6	73·2	58·1	20·74
Experiment 10.					
"Treated with potassium metabisulphite solution."					
(*a*) Potass. Metabisulphite (60 c.c.) . . .	3·6	68·9	71·5	12·1	4·32
Experiment 12.					
"Washed twice in sea-water."					
(*a*) Control to 12 and 13 .	4·2	68·5	71·5	7·0	2·50
(*b*) Sea-water. Double washing . . .	4·0	68·9	71·8	6·0	2·14
Experiment 13.					
"Treated with potassium metabisulphite solution."					
(*a*) Potass. Metabisulphite (100 c.c.) . .	4·2	67·2	70·2	33·5	11·96

SERIES IV.—*cont.*	Moisture.	Oil in copra as received.	Oil in moisture-free copra.	Acid value of extracted oil.	Free fatty acids (expressed as lauric acid).
Experiment 14.	*per cent.*	*per cent.*	*per cent.*		*per cent.*
"Washed in 10 per cent. solution of sodium carbonate and sulphured, using 12 oz. of sulphur and sealing the chamber for 6 hours."					
(*a*) Control to 14, 14*a*, 15 and 15*a*. Unsulphured. Unwashed	3·4	69·7	72·1	9·7	3·46
(*b*) Sodium carbonate 10 per cent. Washed .	3·9	67·4	70·2	14·8	5·28
(*c*) Sodium carbonate 10 per cent. Washed and sulphured .	3·7	66·6	69·2	5·1	1·82
Experiment 14*a*.					
"Washed in 5 per cent. solution of sodium carbonate and sulphured, using 12 oz. of sulphur and sealing the chamber for 6 hours."					
(*a*) Sodium carbonate 5 per cent. Washed .	3·7	67·5	70·1	7·3	2·61
(*b*) Sodium carbonate 5 per cent. Washed and sulphured .	3·6	66·6	69·1	5·9	2·11
Experiment 15.					
"Washed in 5 per cent. solution of sodium hydroxide and sulphured, using 12 oz. of sulphur and sealing the chamber for 6 hours."					
(*a*) Sodium hydroxide 5 per cent. Washed .	3·9	67·7	70·5	12·7	4·53
(*b*) Sodium hydroxide 5 per cent. Washed and sulphured .	3·8	66·5	69·1	2·4	0·86
Experiment 15*a*.					
"Washed in 2½ per cent. solution of sodium hydroxide and sulphured, using 12 oz. of sulphur and sealing the chamber for 6 hours."					
(*a*) Sodium hydroxide 2½ per cent. Washed .	3·9	67·4	70·2	14·3	5·10
(*b*) Sodium hydroxide 2½ per cent. Washed and sulphured .	3·8	67·5	70·2	4·5	1·61

The order of comparative merit (1 to 45) of the extracted oils and the residual meals, classified according to colour, was as follows (in descending order of merit):

Order of merit.	Extracted oils.		Residual meals.	
1	3*a*		15*b*	
2	4*a*		14*c*	
3	7*a*		14-A *b*	
4	6*b*		7*c*	
5	3*b*		3*a*	
6	5*b*		4*a*	
7	14-A *a*		7*b*	
8	5*a*		6*a*	
9	7*b*		15-A *b*	
10	8-A *b*		6*c*	
11	2*a*		6*b*	
12	7*d*		4*c*	
13	4*b*		7*d*	
14	6*a*		8-A *b*	
15	1*d*		11*a*	
16	15-A *a*		4*b*	
17	3*c*		14*b*	
18	15-A *b*		9*a*	
19	1*b*		15*a*	
20	1*c*		8*c*	
21	2*b*		2*a*	
22	15*b*		5*a*	
23	14-A *b*		1*c*	
24	14*b*		15-A *a*	
25	4*a*		5*c*	
26	14*c*		5*b*	
27	4*c*		7*a*	
28	11*a*		14-A *a*	
29	15*a*		14*a*	
30	14*a*		3*b*	
31	5*c*	Brownish	1*b*	
32	7*c*	"	3*c*	
33	8*b*	"	1*d*	
34	6*c*	"	2*b*	
35	1*a*	"	1*a*	
36	2*d*	"	8*b*	Poor
37	10*a*	"	10*a*	"
38	8*a*	"	8*a*	"
39	12*b*	"	12*b*	"
40	8*c*	"	2*c*	"
41	8-A *a*	"	8-A *a*	"
42	2*c*	Pronounced brown	9*b*	"
43	12*a*	Slightly foxy red	2*d*	"
44	13*a*	Foxy red	12*a*	"
45	9*b*	"	13*a*	"

Commercial Valuation

Eight of the samples, as under, were forwarded to a firm of crushers, who submitted the following commercial opinion upon them.

No. 3*a*.—Control sample. Unsulphured ; sun-dried ; protected from rain and covered at night.
No. 8-A *b*.—Sulphured by exposure to fumes of 12 oz. of burning sulphur for 9 hours ; covered.
No. 3*c*.—Sulphured by exposure to fumes of 8 oz. of burning sulphur for 3 hours ; uncovered.
No. 7*d*.—Vara copra sulphured by exposure to fumes of 12 oz. of burning sulphur for 6 hours ; covered.
No. 9*a*.—Washed once in sea-water ; covered.
No. 10*a*.—Sprayed with potassium metabisulphite solution and dried.
No. 14*c*.—Washed with a 10 per cent. solution of sodium carbonate, then sulphured by exposure to fumes of 12 oz. of burning sulphur for 6 hours and dried.
No. 15-A *b*.—Washed with a 2½ per cent. solution of sodium hydroxide, then sulphured by exposure to fumes of 12 oz. of burning sulphur for 6 hours and dried.

" Samples 9*a* and 10*a* are about equal to what we know as FMS Plantation Fiji copra.

" Sample 3*c*, although high in oil content, has its value reduced on account of the very high percentage of F.F.A.'s in the oil, and this appears to be directly due to leaving it exposed to rain and being uncovered at night.

" Of the other samples, 7*d* appears to be the most valuable on account of its high oil content.

" Samples 3*a*, 8-A *b*, 14*c* and 15-A *b* are deficient in oil, but are good from the point of view of F.F.A.'s in the oil, and it may be only a coincidence that the low oil content and low F.F.A. content exist together in these samples. We do not see why the preservative treatment should reduce the oil content of the copra.

" It appears to be important to protect the copra from rain and cover it at night, and the use of burning sulphur as a preservative has a good effect."

CONCLUSIONS

From these series of experiments the following conclusions are drawn. They are based upon the behaviour of the copra during drying, the appearance of the final products, and the analyses of the samples made at the Imperial Institute and the commercial opinion on them.

The chamber used for the sulphuring of the copra was effective for the purpose. It was assembled and dismantled by unskilled labour in less than half an hour and could be readily transported. The chamber was simple to use and proved quite gas-tight.

Copra which had been sulphured and dried with protection from rain and covered at night was of rather better quality than ordinary sun-dried copra similarly protected. The sulphured product had a cleaner and whiter appearance ; it kept better on storage ; it dried to a better quality copra under high humidity conditions ; and it was a little less liable to attack by insects on storage. It, however, was not as brittle as a good quality sun-dried sample, being generally quite leathery and bending rather than fracturing. This may possibly be a disadvantage from the crusher's point of view. Sulphured copra can contain more moisture than the unsulphured product, without excessive mould action taking place. The minimum charge was found to be 12 oz. of sulphur and the time of exposure 3 hours. Longer exposures did not give products of better quality.

The control samples showed that by protecting the nuts during drying from rain and by covering them at night, copra could be readily produced which was of better quality than that produced by the average native. Nevertheless the control copra was not quite as good in appearance as that which had been treated with 12 oz. of sulphur for 3 hours or more.

Copra prepared from germinated nuts is invariably thin and tends to be of lower quality whether it is sun-dried or first sulphured and then sun-dried. The use of germinated nuts should therefore be avoided. Proper and regular collection of the nuts should reduce to a minimum the proportion of germinated nuts.

Sulphuring does not exert any protective influence on

copra if the nuts are dried without being covered at night and during rain. Sulphured and uncovered nuts do not resist the attack of moulds during drying and are more attractive to copra beetles. As the amount of sulphuring increased, so the particular copra became more charred in appearance and poorer in quality. Sulphuring does not improve copra which is neglected during drying.

In the experiments with sea-water mould action was not arrested and the tests showed that a preliminary washing with sea-water is more injurious than beneficial to copra when the drying conditions are unfavourable.

Nuts treated with a solution of potassium metabisulphite were badly attacked by moulds and yielded copra of very poor quality. The use of this solution did not fulfil the object of the experiments.

Nuts that had received a preliminary washing with a solution of sodium carbonate, when sulphured before drying gave copra of slightly better appearance than that prepared from nuts which were treated with caustic soda before sulphuring and drying. The main advantage of washing the nuts with a solution of sodium carbonate before sulphuring and drying was that on storage even for as long as a year the resulting copra successfully resisted all mould and insect attack, although the samples were stored with other samples of copra in which beetles were present. This freedom from attack may be due to the presence of sodium sulphate in the copra caused by the oxidation of the product of the action of sulphur dioxide on the alkali.

Washing green copra in a 10 per cent. solution of sodium carbonate and then subjecting it while still wet to the fumes of burning sulphur seems to offer possibilities for adoption for commercial use. The advantages are the facility and cheapness with which carbonate of soda can be obtained ; the clean appearance and high quality of the resulting copra ; the prevention of mould and insect attack and therefore a reduction of the loss in weight on storing the product.

One effect of sulphuring copra and drying it under cover would appear to be that the oil extracted from the product is of lower acidity than that from either the

control or the uncovered samples. This difference becomes more marked in the case of copras that have been stored for any considerable period.

Copra that had been prepared by washing the nuts in a solution of sodium carbonate or caustic soda, sulphuring while still wet and subsequent drying with protection from rain and at night, yielded, after storage for 9 months, oils the acidity of which was in every case lower than that of the oils from the control and from the unsulphured samples.

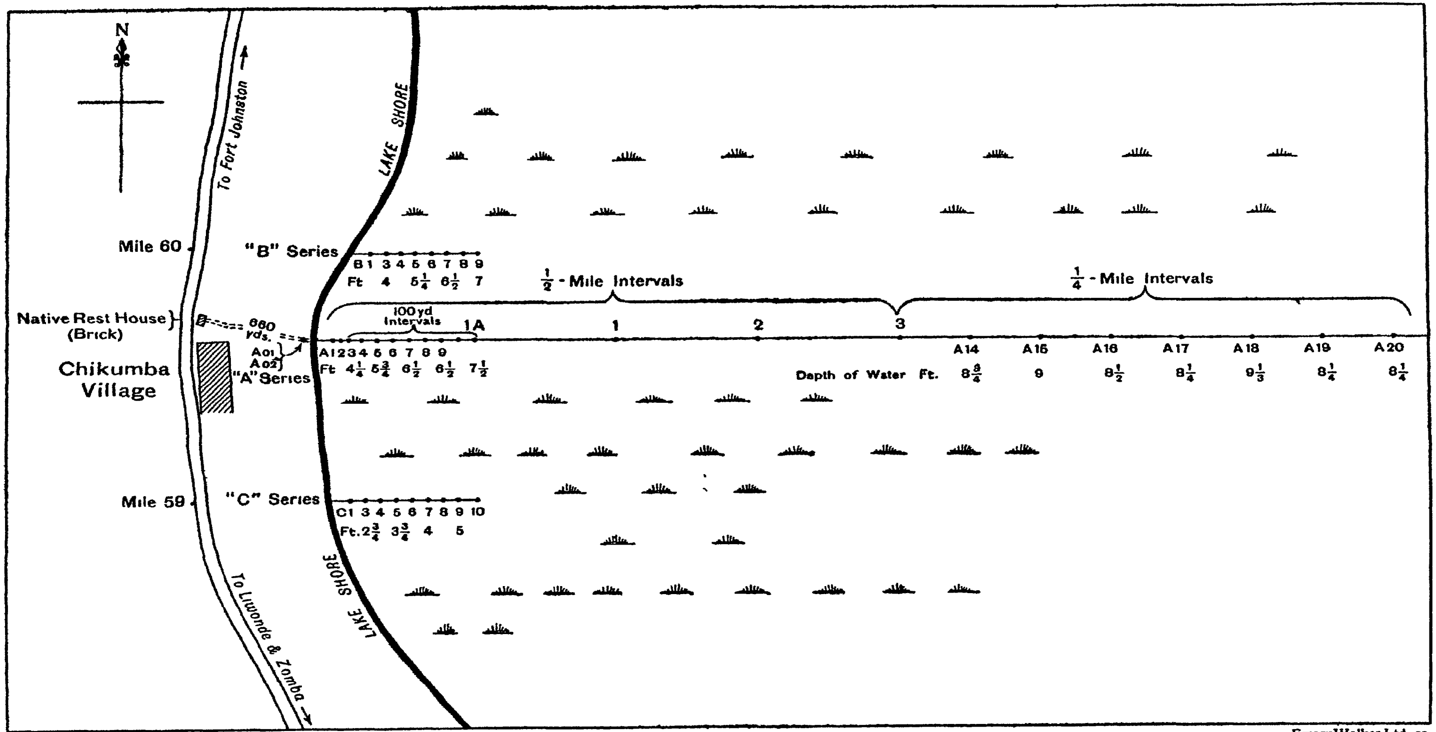
It will be seen from the above that the most promising method so far found for improving the quality of Fiji copra is to use only nuts which are ungerminated and to prepare copra from them by a preliminary washing of the cut nuts in a 10 per cent. solution of sodium carbonate followed by their exposure while still wet to the fumes of burning sulphur and subsequent drying with protection from rain and covered at night.

CEMENT-MAKING MATERIALS FROM NYASALAND

Amongst the numerous investigations carried out at the Imperial Institute on calcareous and argillaceous materials from Nyasaland with a view to determining their suitability for local cement manufacture, that recently concluded on materials from Lake Malombe is probably the most interesting.

Chemical analyses and technical trials made at the Imperial Institute in 1925 with a sample of calcareous clay from the bed of Lake Malombe showed that the material was suitable for making natural cement, and an account of this investigation was published in this Bulletin (1926, **24**, 312–314).

This lake, which is situated in the Upper Shire Valley, 10 miles south of Lake Nyasa, is subject to flooding, and when in flood occupies an area of fully 100 square miles. The bed of the lake is covered with a layer, not less than 10 feet in thickness, of calcareous clay, varying in composition over a wide area, and pale grey to black in colour.



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SKETCH-MAP OF PART OF LAKE MALOMBE, NYASALAND, SHOWING LOCATION OF SAMPLES OF CLAY, AND THE REED AREAS.
Samples 1A, 1, 2 and 3 were collected in May 1930, and the A, B and C series in November 1930.
(From a sketch-map prepared by the Geological Survey Department, Nyasaland.)

At the time the original sample was collected the portion of the bed from which it was taken was dry, but this area is now completely covered with water, with patches of reeds extending locally for several miles into the lake.

Since the results obtained with the original sample were very promising, and the deposit is so extensive, further samples were sent, and were examined in July 1930. These gave less satisfactory results, but later investigations showed that mixtures of clays from different portions of the lake bed would yield, on burning, Portland and natural cements of good quality.

Late in 1930, as a result of a subsequent survey by the Geological Department of Nyasaland of a defined portion of the lake bed, 35 further samples of the clay were forwarded to the Imperial Institute for analysis and technical trial, and it is considered that a detailed account of these tests and a consideration of the results obtained will be of interest.

The 35 samples in question were taken from the points indicated by the A, B and C series on the accompanying sketch-map. The positions from which samples were previously taken in 1930 are also indicated at the points 1A, 1, 2 and 3 on the map. There is said to be sufficient open water between the patches of reeds to permit of working the clay bed.

Results of Examination

The work carried out at the Imperial Institute with the clays may for convenience be divided into four parts: (A), chemical analyses ; (B), preliminary trials ; (C), production of Portland cement ; and (D), production of natural cements and hydraulic limes.

(A) Chemical Analyses

Representative portions of the samples, after air drying, were submitted to partial chemical analysis at the Imperial Institute, with the results shown in the table below. For purposes of comparison, the analyses of the samples examined in 1930 (Nos. 1A, 1, 2 and 3 on the sketch-map) are also shown.

CHEMICAL ANALYSES OF CALCAREOUS CLAYS FROM LAKE MALOMBE

(In percentages)

1931 Series

	Ao. (1′–2′)	Ao. (3′–4′)	A1.	A2.	A3.	A4.	A5.	A6.	A7.	A8.	A9.	A14.	A15.	A16.	A17.	A18.	A19.	A20.	B1.	B3.
Silica .	39·85	39·20	38·67	36·32	24·75	10·92	10·88	9·74	7·25	6·84	5·43	5·52	4·10	5·22	5·67	6·85	5·30	9·02	39·67	34·41
Alumina .	19·04	18·02	19·47	16·17	9·49	4·56	5·18	5·13	4·06	3·50	2·71	0·73	0·56	0·38	1·81	2·49	2·52	2·66	18·62	14·07
Ferric oxide .	10·54	10·30	9·26	7·57	4·80	2·85	2·69	2·77	1·75	1·64	1·55	1·22	0·74	0·82	1·13	1·28	1·15	1·50	9·50	7·57
Titanium dioxide .	0·99	1·08	1·07	0·99	0·56	0·27	0·33	0·30	0·26	0·20	0·17	0·12	0·05	0·05	0·09	0·10	0·14	0·14	1·42	0·88
Lime .	1·93	1·47	0·89	1·42	16·93	34·98	34·22	33·74	39·77	40·24	42·82	45·09	45·43	44·51	44·63	43·50	43·24	41·15	2·41	2·52
Magnesia .	1·86	1·97	2·03	2·29	1·51	1·66	1·83	1·74	1·78	1·69	1·69	1·38	1·99	1·25	1·70	1·70	1·76	1·70	2·22	2·12
Loss on ignition .	20·44	23·14	25·02	31·59	40·98	43·49	42·25	43·77	43·81	44·30	44·96	44·96	46·00	45·78	44·86	44·37	44·68	43·35	20·47	33·74

1931 Series / 1930 Series

	B4.	B.5.	B6.	B7.	B8.	B9.	C1.	C3.	C4.	C5.	C6.	C7.	C8.	C9.	C10.	1A.	1.	2.	3.
Silica .	11·28	11·65	10·25	4·74	4·90	5·79	45·85	36·80	11·59	12·85	11·96	9·21	11·12	10·93	11·44	4·42	5·03	3·85	3·55
Alumina .	3·93	4·43	6·00	0·81	0·92	2·92	17·00	11·32	4·14	1·47	4·39	4·78	6·38	6·10	6·37	2·65	2·61	1·82	1·49
Ferric oxide .	2·70	2·21	2·37	1·19	1·31	1·61	9·17	8·19	3·19	2·62	2·70	2·49	2·73	2·74	3·15	0·90	1·10	0·98	0·79
Titanium dioxide .	0·24	0·22	0·23	0·10	0·17	0·14	0·94	0·88	0·28	0·25	0·16	0·18	0·31	0·31	0·28	—	—	—	—
Lime .	36·19	36·45	32·85	44·07	43·90	43·00	2·26	8·79	34·02	36·57	34·36	34·62	31·82	33·36	30·94	44·19	43·46	44·85	45·72
Magnesia .	1·60	1·61	1·65	1·71	1·50	1·70	2·29	1·60	1·62	1·09	1·44	1·59	1·66	1·90	1·55	1·76	1·52	2·04	1·87
Loss on ignition .	41·22	42·32	44·72	45·42	45·05	44·21	17·54	28·58	43·06	42·22	43·13	45·90	43·64	42·54	46·30	44·98	45·28	45·88	46·01

Organic matter, sulphuric anhydride and alkalies were not determined (except in samples 1A, 1, 2 *and* 3, *where the percentages of sulphuric anhydride,* SO_3, *were* 0·40, 0·33, 0·36 *and* 0·28 *per cent. respectively).*

A number of the clays contained considerable amounts of organic matter, which probably accounts in part for the high loss on ignition shown by certain samples. As the analyses were performed as soon as possible after air-drying the samples, some moisture is probably included in the figures for "loss on ignition."

(*B*) *Preliminary Trials with Samples A*o (1′–2′), *A*o (3′–4′) *and A*1 *to A*9

The analyses of samples Ao (1′–2′), Ao (3′–4′) and A1 and A2 indicated that they would be unsuitable for use for making natural cement. The materials, owing to their low ratios of silica to alumina, would also be generally unsuitable for use in the manufacture of Portland cement in conjunction with highly calcareous materials also having low ratios of these constituents. Such a low ratio often results in a reduction in the softening point of the raw mixtures, and the consequent risk of partial fusion during calcination. A low ratio of silica to alumina may also cause the cement produced to have very quick-setting properties, which may be difficult to control. The addition of finely divided siliceous matter, with a view to altering this ratio, is sometimes adopted in practice, but this would naturally complicate the manufacture considerably.

Sample A3, after being burnt in lumps, at a temperature of 900° C. to 1000° C. did not slake when mixed with water, but when the burnt material was finely ground and gauged with water, the mass set in 10 to 15 minutes, and after being kept in damp air for a few days gave a fairly hard product. Thus the preliminary results obtained with this sample were promising.

The remaining samples (A4 to A9), contained much higher proportions of lime than did those mentioned above, and in that respect were more suitable for the preparation of hydraulic lime than for natural cement.

Preliminary burning trials showed that the irregular distribution of the lime throughout samples A4 to A9 prevented its complete combination with the argillaceous constituents on burning, and the burnt lumps, when treated with water, slaked in varying degrees in different

portions of the mass. The products, when finely ground and gauged with water, set in a few minutes and slowly hardened.

It is probable that material represented by these six samples, although not capable of yielding true natural cements, would give useful products of a similar nature, but further experiments would be necessary to ascertain the best method of treatment.

It is improbable that material represented by samples A7 to A9 would be suitable for the manufacture of Portland cement of normal composition, and the only means by which they could be employed for the production of a Portland cement of any description would appear to be by using them in conjunction with an appropriate calcareous clay having an extremely high ratio of silica to alumina.

It is possible that cements approximating in composition to an ordinary Portland cement might be produced from material represented by samples A4, A5 or A6, if they were first finely ground so that homogeneous mixtures of the calcareous and argillaceous constituents could be made before burning. The cements produced, however, especially those from A5 and A6, would probably be of an exceedingly quick-setting character, and this might be difficult to control.

A better Portland cement would be obtained by grinding and mixing 1·6 parts of No. 3 (of the series of samples examined in 1930) with 1 part of A3 of the present series. The cement produced in this way would probably be superior to those made by merely grinding and burning either A4, A5 or A6, as suggested above.

It appears probable also that a Portland cement, fairly satisfactory as regards its chemical composition, could be made from a mixture of about 3 parts of No. 3 of 1930, referred to in the previous paragraph, and 1 part of A2 of the present series. This cement would also, however, probably be very quick setting.

(C) *Experimental Manufacture of Portland Cement*

The composition and physical condition of certain of the clays indicated that Portland cement, not necessarily of normal composition, might be produced from them

individually without the necessity for admixture with other samples, provided that they were finely ground and well mixed before being burnt.

The samples suited to this treatment which, at the same time, appear to occur in conveniently situated positions in the lake bed, are Nos. A4, A5, A6 ; B4, B5, B6 ; C4, C5, C6.

Small quantities of cement were accordingly prepared from each of the above samples, and when tested for soundness were found to be quite satisfactory.

In most cases the quantity of cement produced was too small to permit of full-sized test pieces being made to ascertain the setting properties of the individual samples by means of the usual Vicat needle test, but gentle pressure with the finger on the side of a small pat of each of the gauged cements showed that they all commenced to lose their plasticity very quickly, the maximum " initial setting time " as thus determined being about 10 minutes. By incorporating 2 per cent. of finely ground gypsum with the cements and exposing the mixture to steam at atmospheric pressure in a closed vessel for 20–30 seconds, the setting times of nearly all the cements prepared were found to have been materially lengthened, in some instances to nearly an hour.

A more convenient method of adjusting the setting time, under large-scale conditions of burning, would be the watering of the clinker, with subsequent addition of gypsum or plaster of Paris, in lieu of the steaming process adopted in this investigation.

The remarks regarding the effect of the ratio of silica to alumina on the burning of the raw mixture and on the setting time of the cement, referred to earlier in this report, apply also to samples A4 to A6, B4 to B6, and C4 to C6.

Particular attention was given to this group of samples on account of the apparent accessibility of the portions of the lake bed from which they had been obtained, and the ease with which the materials could be treated for the manufacture of a Portland cement. It would probably be possible to run a plant using these materials with little chemical control other than perhaps that of checking the calcium carbonate content, in order to ensure that it is

kept within the limits necessary for the production of a sound cement. The quality of the cements produced under such conditions would, however, be variable, since there could be no standardisation of the raw mixture.

It appears probable that in the lake bed there exists a belt of material running through the points from which these samples were taken, which would furnish raw material for the production of a Portland cement suitable for local building requirements, and which would probably comply with the requirements of the British Standard Specification (1925). The belt would seem to be at least one mile in length, two to three hundred yards in width, and to run more or less parallel with, and comparatively close to, the shore of the lake.

Since all of the samples from this belt gave sound cements, it is evident that they could be bulked together in any proportions, and when treated as described will yield good cements varying in strength according to the composition of the particular samples and the quantity of each selected.

A practical burning trial was carried out on a mixture composed of the following proportions of the air-dried materials (the variable weights taken being necessitated solely by the quantity of material available for trial):

A4.—30 parts.	B4.—5 parts.	C4.—5 parts.
A5.—15 parts.	B5.—5 parts.	C5.—2 parts.
A6.—20 parts.	B6.—3 parts.	C6.—3 parts.

After burning, 2 per cent. of gypsum was added to the clinker, and the whole ground and then steamed for 20 seconds in a closed vessel.

The calculated composition of the cement produced from the mixture (before the addition of the gypsum) was as follows:

		per cent.
Silica	SiO_2	19·66
Alumina	Al_2O_3	8·55
Ferric oxide	Fe_2O_3	5·01
Titanium dioxide	TiO_2	0·51
Lime	CaO	63·22
Magnesia	MgO	3·05

Mechanical and physical tests of the cement produced gave the following results:

6 PHYSICAL TESTS ON PORTLAND CEMENT MADE FROM A MIXTURE OF SAMPLES A4 TO A6; B4 TO B6; C4 TO C6

Time of setting.	Fineness of grinding.	Tensile strength of briquettes 1 sq. in. section; the load being applied at the rate of 100 lb. per 12 seconds.[1] Neat cement. At 7 days after gauging.	Cement with 3 parts standard sand. At 7 days after gauging.	Cement with 3 parts standard sand. At 28 days after gauging.
Hours. Mins. Initial . . 1 28 Final . . 4 18 Water used for gauging = 19·5 per cent. Temperature of room = 61° F.	Residue on a sieve having 32,400 meshes per sq. in. = 5·0 per cent. Residue on a sieve having 5,776 meshes per sq. in. = 0·6 per cent.	lb. per sq. in. 705 770 770 670 725 680	390 365 355 380 340 360	445 405 425 425 440 420
		Mean 720	365	427
Expansion in Le Chatelier apparatus after 6 hours in water heated to 100° C. Cement aerated 24 hours = 3 mm.		Briquettes were gauged with 19·5 per ccnt. of water.	Briquettes were gauged with 7·37 per cent. of water. Minimum specification requirement at 28 days after gauging = 392. (mean at 7 days + $\frac{10,000}{\text{mean}}$)	

[1] *Cement aerated 24 hours for these tests.*

The cement, which had convenient setting properties and good strength, easily satisfied the requirements of the (1925) British Standard Specification for Portland cement.

Certain combinations of the materials from other parts of the lake bed might be expected to yield cements equal in quality to that produced from the individual samples already described, but in such cases greater care would be needed in controlling the composition of the raw mixture, owing to the more varied nature of the components. It is not known, however, whether deposits of any particular composition exist in sufficient quantity to enable a large bulk of cement, uniform in quality, to be obtainable from such mixtures.

The rather unsatisfactory composition of most of the samples is an important factor when cements of normal composition are required, but consideration has been given in this investigation to the desirability of producing, from as much of the available material as possible, Portland cements which would suffice for local constructional purposes, although such cements would not necessarily be of normal composition. Four such mixtures are detailed below.

Mixture No. 1.—The chemical analyses show that the four samples, A0 (1′–2′), A0 (3′–4′), A1 and A2 could be mixed with B7 and B8, which have a much higher ratio of silica to alumina than the first-mentioned samples, while their lime content is also fairly high.

In order to simplify working, equal parts by weight of B7 and B8 could form the calcareous portion of such a mixture, the argillaceous constituents being made up of equal parts by weight of each of the above " A " samples. When 4·8 parts by weight of the calcareous portion were mixed with 1 part by weight of the argillaceous mixture and burnt, a clinker was obtained which, on being ground, gave a cement which, after the addition of 2 per cent. of gypsum and steaming, commenced to set in 5 hours and hardened well in 24 hours after gauging, the pats made being sound.

Other small-scale burning trials were made on the following combinations :

Mixture No. 2.—A3, 3 parts by weight ; A4, A5 and

A6, 1 part of each ; A7, 4 parts ; A8 and A9, 3·5 parts of each.

Mixture No. 3.—Equal parts of A14, A15, A16, A17 and A20 with A3. 2·45 parts by weight of the mixture of the former 5 samples to 1 part by weight of A3.

Mixture No. 4.—3·7 parts by weight of B3 to 1 of B8.

CALCULATED COMPOSITION OF MIXTURES NOS. 1, 2, 3 AND 4

		No. 1. *per cent.*	No. 2. *per cent.*	No. 3. *per cent.*	No. 4. *per cent.*
Silica . . .	SiO_2	19·00	18·88	20·59	20·42
Alumina . .	Al_2O_3	6·90	8·64	6·55	6·79
Ferric oxide . .	Fe_2O_3	4·77	4·34	3·92	4·82
Titanium dioxide .	TiO_2	0·50	0·55	0·40	0·62
Lime . . .	CaO	65·75	64·31	65·70	64·35
Magnesia . .	MgO	3·00	3·04	2·84	2·98

The initial setting times of the cements prepared from the above samples after treatment with steam and 2 per cent. gypsum were in all cases about 1 hour.

Many other combinations of the samples could be suggested to give good cements, but, as already mentioned, it would probably be found difficult in practice to maintain a standard composition for the cements so produced.

It may be found, however, that certain other clays occur in juxtaposition which, when grouped, would yield a supply of workable material of fair extent (such for instance as samples A14 to A20 or B7 to B9) and suitable for combination with appropriate materials.

If it is decided to work the Lake Malombe deposit for Portland cement manufacture, before plant is erected the behaviour of the material when large quantities are ground and burnt in an experimental kiln should be investigated. Should these experiments show that the superincumbent weight of the material acting on the softened clinker in the lower portion of the kiln does not consolidate the mass or affect the draught, it would appear reasonable to anticipate that a satisfactory cement could be produced commercially.

(*D*) *The Production of Natural Cements and Hydraulic Limes*

(1) *Natural Cement from Sample No. A*3

In the course of the preliminary work on the eleven samples dealt with in the first part of this report (see pp. 143-

144), it was found that No. A3 was the only sample which, when burnt, gave promising results as a natural cement.

A burning on a larger scale was, therefore, made of this material, the sample being broken into lumps about 1-in. cube and burnt in a gas-fired furnace for 3 hours at a temperature of 980° to 1,000° C.

If it be assumed that complete combination occurs between the lime and the argillaceous constituents, the composition of the burnt product, calculated from the chemical analysis of the raw material, would be as follows :

		per cent.
Silica	SiO_2	42·10
Alumina	Al_2O_3	16·15
Ferric oxide	Fe_2O_3	8·20
Titanium dioxide	TiO_2	0·95
Lime	CaO	29·00
Magnesia	MgO	2·60

The clinker, which was very soft, was ground to such fineness that a residue of 6·6 per cent. was left on a sieve having 32,400 meshes per sq. in.

In the absence of a British Standard Specification for natural cement, the cement produced was tested in accordance with the Specification for Natural Cements, 1930, of the American Society for Testing Materials, so far as the quantity available allowed, and the following results were obtained :

Fineness of Grinding.—The cement complied with the specification requirements.

Soundness.—Pats of the gauged cement, stored in air and water respectively, remained firm and hard, and showed no signs of distortion, cracking or disintegrating, and therefore complied with the specification.

Time of Setting.—When tested with the Vicat needle, the cement had an initial setting time of 50 minutes and a final setting time of 24 hours. In respect of this latter test, the sample fails, as the specification requires an initial setting time of not less than 10 minutes and a final setting time of not less than 30 minutes nor more than 3 hours. It is of interest to note that when burned at a temperature of 900° C. for 3 hours, the sample had an initial setting time of 30 minutes and a final setting time

of 7 hours 5 minutes, and thus, in spite of the much shorter final set, also failed to comply with the specification.

Tensile Strength of Neat Cement.—Briquettes, gauged with 50 per cent. of water and thumb-pressed into the moulds, were stored in a moist chamber for 24 hours, after which they were removed from the moulds and placed in water until due for testing at 28 and 56 days from gauging.

Two briquettes when broken at 24 hours after gauging showed a tensile strength of only 14 lb. per sq. in., and, as the cement was evidently very slow in hardening, no further briquettes were broken at that period.

The following results were obtained :

NATURAL CEMENT A3, NEAT CEMENT TEST

(Tensile strength in lb. per sq. in.[1])

	At 7 days.	*At 28 days.*	*At 56 days.*
	36	100	175
	36	80	250
	36	112	192
	–	95	198
	–	120	175
Mean .	36	101	198

[1] *Cement was insufficient to make six briquettes at each date.*

The minimum strengths required by the above-mentioned specification under the neat cement test at 24 hours, 7 days and 28 days are 75, 150 and 250 lb. per sq. in. respectively.

The specification does not require a tensile strength test at 56 days after gauging, but its inclusion in the case of a slow-hardening cement is valuable as showing the progress of hardening during further storage.

The figures obtained by the neat cement test show that the cement is very slow in hardening, and does not comply with the specification in respect of the strength of the neat briquettes at either 24 hours, 7 days or 28 days.

Tensile Strength of 3 to 1 Sand-cement Briquettes.—Three parts of British standard cement-testing sand were mixed with 1 part by weight of cement and the mixture gauged with 15 per cent. of water. The briquettes were stored in a moist cupboard for 24 hours, when they were

removed from the moulds and placed in water, where they remained until due for breaking.

The following results were obtained :

NATURAL CEMENT A3, SAND-CEMENT TEST

(Tensile strength in lb. per sq. in.[1])

	At 7 days.	*At 28 days.*	*At 56 days.*
	45	152	192
	45	140	180
	45	130	192
	–	135	182
	–	–	172
Mean .	45	139	184

[1] *Cement was insufficient to make six briquettes at each date.*

The strengths at 7 and 28 days required by the specification are 50 lb. and 125 lb. respectively. The strength at 56 days is not specified, but the results obtained show a satisfactory increase in strength over the 28 days' test. Although the strength at 7 days is just below that required by the specification, that at 28 days slightly exceeds the specified amount.

The results of the sand test as a whole are markedly higher than those of the neat test at early dates, but the latter appears to be showing a proportionately greater strength as the longer periods of ageing are approached, and would probably have shown an increase over the strength of the sand briquettes at 6 months, and longer, had sufficient material been available for making the tests.

No retrogression of strength with age was shown by either neat cement or sand-cement briquettes.

(2) *Hydraulic Limes*

Samples Nos. A0 (1′–2′) ; A0 (3′–4′) ; A1 and A2.—These materials were of no value for the production of natural cements or hydraulic limes.

Samples A4 to A9.—Experiments were carried out to determine whether samples A4 to A9 would yield hydraulic limes when burnt without preliminary preparation.

The material for the tests was broken into lumps of

about 1-in. cube and burnt in a gas-fired furnace for $3\frac{1}{2}$ hours at a temperature of 1,000° C. The resulting lime was ground to such fineness as to leave a residue of about 24 per cent. on a sieve having 32,400 meshes per square inch, gauged with the requisite quantity of British standard cement-testing sand and water for 15 minutes without previous slaking, and then made into briquettes. Preliminary experiments indicated that stronger mortars would be obtained if the limes were treated in this way rather than if they were slaked for some hours with damp sand before being made into mortar. In practice, the dry materials and water would be thoroughly incorporated in a mortar mill, during which process slaking would take place. When gauging the materials it was found that the mass heated considerably and stiffened somewhat during the first few minutes of mixing, after which a smooth working mortar was obtained.

In all cases the mortars were brought to a definite consistency, which was about the same as that used for setting bricks.

In preparing the test briquettes the mortar was pressed into the moulds with the thumbs and then levelled flush with the top surface of the mould. The test pieces were then stored under the following conditions :

(1) The briquettes were removed from the moulds 24 hours after making, and left in the air of the laboratory until due for testing.

(2) The briquettes, after removal from the moulds as above, were left in air for 21 days, and then placed in water until due for testing.

(3) The briquettes, after removal from the moulds as above, were left in air for 21 days and then placed in moist air of about 90 per cent. humidity.

(4) The moulds containing the test briquettes were left in moist air for 2 days, and the briquettes then removed and kept under similar conditions until due for testing.

(5) After removal from the moulds as in No. 3, the briquettes were left in moist air for 21 days and then placed in water until due for testing.

The storage under (1) above resembles the treatment a

mortar would receive when used exclusively for interoir work.

The results under storage conditions (2) show the increased strength under water treatment due to the hydraulic properties of the limes. The results obtained with the less drastic treatment under (3) often give a better indication as to the hydraulic nature of the material due to ageing under moist conditions than does complete immersion in water.

Tests under (4) and (5) are of value as indicating the behaviour of a mortar left to age in a damp or wet situation.

For purposes of comparison the results of tests obtained with two good-quality commercial grey-stone limes of the feebly hydraulic type tested under similar conditions to the above are also shown in the table on p. 155.

In the case of the lime prepared from sample A6, which from preliminary experiments appeared more promising than the others, it was thought desirable to compare it with a strongly hydraulic lime of the Blue Lias class. For this purpose 1 part of the lime to be compared was mixed with 5·58 parts by weight of British standard cement-testing sand, and gauged and tested in the same way as the weaker limes. These results are shown in the table on p. 156, and indicate that the lime produced is about equal in strength to commercial Blue Lias lime, although in two of the tests at 182 days a retrogression in strength from that attained at 91 days was shown.

The above results indicate that the limes produced by burning these samples are either equal or somewhat superior in strength to the grey-stone lime in general use for ordinary mortar making in constructional work.

The mortar made from sample A9, however, is generally inferior, at 182 days, to those made from the grey-stone limes with which it was compared.

Samples A14 to A20.—As seen from the analyses given on p. 142, these samples are all highly calcareous, the lime content decreasing as the centre of the lake is approached.

Technical trials indicated that the samples, when burnt in lumps, would be of little value as a source of hydraulic

TESTS ON HYDRAULIC LIME MORTARS MADE FROM SAMPLES A4 A5 AND A7 TO A9

Tensile strength (in lb per sq in) of mortars composed of British standard cement-testing sand and lime

Sample No	—	Storage conditions. Normal air only (No 1)				Normal air then in water (No 2)				Normal air then moist air (No 3)				Moist air only (No 4)				Moist air, then in water (No 5)			
	Age (in days) from date of gauging →	28	56	91	182	28	56	91	182	28	56	91	182	28	56	91	182	28	56	91	182
	Composition of mortar Parts by volume[1] (the lime being in 1-in lumps or smaller) Sand Lime																				
A4	0 85 1	97 (5)	89 (5)	91 (5)	176 (5)	60	122 (5)	165 (5)	189	Not made				101	146 (5)	156 (5)	138 (5)	68	118 (5)	150	178 (5)
A5	0 79 1	55	57	65	82	55	83	86	96	59	62	64	72	121 (4)	146 (4)	125 (3)	Not made	69 (4)	76 (4)	88 (4)	Not made
A7	0 83 1	42 (4)	47 (4)	52 (4)	57 (4)	32 (5)	56 (4)	55 (4)	73 (5)	38 (4)	45 (4)	48 (4)	51 (4)	70 (5)	99 (5)	110	99 (4)	51 (5)	57 (5)	56	70 (4)
A8	0 85 1	61 (5)	76 (4)	74 (4)	84 (4)	49 (5)	79 (4)	81 (4)	94 (4)	60 (5)	56 (4)	70 (4)	77 (4)	97 (5)	111 (5)	107 (4)	90 (4)	54 (5)	74 (5)	77 (4)	91 (3)
A9	0 83 1	33 (5)	39 (5)	47 (4)	56 (4)	24 (5)	34 (5)	40 (4)	57 (4)	33 (5)	37 (5)	39 (4)	44 (3)	41	42 (5)	48 (5)	50 (5)	Not made			
Grey-stone "A"	1 41 1	27	36	51	80	23 (7)	60	96	107	31	37	38	69	Not made				Not made			
Grey-stone "B"	1 1	29	26	40	54	Not made				Not made				42	74	88	113	26	51 (7)	82 (7)	Note made

Unless otherwise stated in brackets, the figures given are the mean breaking strength of six briquettes.

[1] *Equivalent in all cases to 2 6 parts by weight of sand to 1 part of lime*

COMPARATIVE TESTS ON LIME FROM NO. A6 AND COMMERCIAL BLUE LIAS LIME

Tensile strength in lb. per sq. in. of mortars composed of British standard cement-testing sand and lime

Sample No.	—	Storage conditions.																			
		Normal air only. (No. 1.)				Normal air, then in water. (No. 2.)				Normal air, then moist air. (No. 3.)				Moist air only. (No. 4.)				Moist air, then in water. (No. 5).			
	Age (in days) from date of gauging →	28	56	91	182	28	56	91	182	28	56	91	182	28	56	91	182	28	56	91	182
A6 Blue Lias lime	Composition of mortar. Parts by volume[1] (the lime being in 1-in. lumps or smaller). Sand : Lime 1·74 : 1	50	50	54	61	52	68	69	69	54	60	60	47	76	85	118	65	46	60	58	73
	3·0 : 1	32	50	50	52	42	75	84	94	41	50	61	85	Not made				Not made			

The figures given are the mean breaking strength of six briquettes in each case.

[1] *Equivalent in all cases to 5·58 parts by weight of sand to 1 part of lime.*

material. In every case the product slaked vigorously, the ground material "set," but did not harden to any extent. After being stored in a moist atmosphere for two months, briquettes made from the limes showed very little strength.

It is possible that the slaked lime might be used for rough plastering ("rendering") over brick or similar surfaces where little strength is needed, but the slight "set" caused by the impurities present might interfere with the workability of the mass. The limes could not be expected to give the smooth working results associated with highly plastic "fat" limes.

Samples B1, B3, B4 and B5.—Of this series B1 and B3 are unsuitable for the production of hydraulic lime, but they might find application in Portland cement manufacture.

Natural cements were produced when B4 and B5 were burnt, in lumps as received, for 3 hours at a temperature of 1,000° C. The clinker so produced, after grinding, heated somewhat when gauged with water and set in a few minutes, but pats made with the cement hardened well and were perfectly sound. The ground cement, if stored for a day or two, did not heat when gauged with water, but the setting time remained very quick.

Sample B6.—When burnt at a temperature of 1,000° C., the lime in this sample did not appear to combine so readily with the argillaceous constituents as did that in B4 and B5. In practice the clinker would need sprinkling with water before grinding, in order to slake any free lime present. This treatment would break down the lumps to some extent and thus facilitate the grinding process. The burnt material resembles a hydraulic lime more than a natural cement, the clinker of which should theoretically need no slaking or aeration before grinding to give cement.

Pats gauged from the slaked and ground clinker set in a few minutes, hardened well and were perfectly sound.

Calcination of the raw material at a higher temperature than 1,000° C., however, gave a product which did not slake when water was added to the lumps of clinker, and the latter, after grinding and gauging with water, gave pats which were unsound.

The limes produced by burning samples B7, B8 and B9 behaved similarly to those obtained from samples A14 to A20, and the same remarks apply both as to their use as plastering limes and in Portland cement manufacture.

Samples C1 and C3.—These might possibly be useful in certain cases for admixture with other materials for Portland cement manufacture.

Sample C4 was burnt in lumps at 1,000° C., and the ground product on slaking heated and set in 2 minutes. Pats made from the slaked material hardened well and were quite sound. It should make a fair quality natural cement.

In order to obtain a sound cement from sample C5, the clinker produced by burning the material at 1,000° C. would need much the same treatment as that obtained from B6. The cement set in a few minutes when gauged with water.

Sample C6 when burnt at 1,000° C. for 3 hours, slaked freely, and after being left for 6 hours, and then ground to a stiff paste with water, set in about 30 minutes and hardened well. It could be used for the production of hydraulic lime.

Samples C7 to C10, after burning at 1,000° C. and slaking, gave pats which hardened fairly well, and the materials would probably give good results as hydraulic limes. Samples C8 and C10 do not slake readily, but it is possible that by burning at a slightly higher temperature, natural cements might be produced from them. Much depends, however, on the distribution of the calcareous portion. If it is not evenly distributed, an increased kiln temperature will result in the free lime being overburnt, and will give a product which, when ground to cement, would probably "blow" in use, a defect which could be overcome only by very prolonged aeration of the cement.

It may be remarked here that the dividing line between hydraulic limes and natural cements is by no means definite. It is quite possible that by slight modification in treatment, such as an alteration in the temperature and time of burning, some of the samples would yield either one or the other class of hydraulic material.

The results of the technical trials described above are sufficient to outline the varied aspects which the materials present, but in considering the economic possibilities of the deposit, its variability in composition throughout the lake bed must be kept in view.

Summary and Conclusions

Portland Cements.—The preparation from the Lake Malombe clays of raw mixtures suitable for burning to a Portland cement clinker is possible by merely grinding finely certain of the individual samples from the lake bed. The resulting cement would comply in all respects with the (1925) British Standard Specification for Portland cement.

Combinations of certain others of the samples are also feasible, but difficulties may be encountered in large-scale production, and preliminary trials are necessary on a larger scale than is possible under laboratory conditions.

Natural Cements.—The results show that material represented by sample No. A3, when burnt and ground, would yield a natural cement showing good strength under the mortar test ; the strength of the cement is, however, relatively poor when tested without admixture with sand.

Hydraulic limes varying in strength were produced by burning certain other of the eleven bulk samples in the " A " series of clays from Lake Malombe, most of which were superior in strength to a commercial grey-stone lime, while the lime produced by burning sample A6 was of superior strength and equal to that of a Blue Lias lime of good quality.

The samples of the " A " series which appear likely to yield hydraulic limes are Nos. A4, A5, A6, A7, A8 and A9.

Hydraulic limes were produced by burning samples B6, C5, C6, C7, C8, C9 and C10, natural cements from B4, B5, C4, and inferior limes (which might possibly be used as a rough rendering on walls) from A14 to A20 and B7 to B9.

Samples B1, B3, C1 and C3 might be useful in Portland cement manufacture.

ARTICLES

THE EMPIRE FRUIT INDUSTRY

THE following paper by Mr. W. G. Freeman, B.Sc., A.R.C.S., F.L.S., of the Imperial Institute, late Director of Agriculture, Trinidad and Tobago, was read before a meeting of the Dominions and Colonies Section of the Royal Society of Arts held on February 23, 1932, Lieut.-General Sir William Furse, K.C.B., D.S.O., Director of the Imperial Institute, in the Chair. It is reprinted from the *Journal of the Royal Society of Arts*, Vol. LXXX, No. 4142, April 8, 1932, by kind permission of the Society.

The Empire Fruit Industry is a wide subject to a very small part of which all the time at our disposal this afternoon could profitably be devoted.

This, however, is a meeting, held in the heart of the Empire, of that section of your ancient Society which, for over one and three-quarter centuries, has taken an active interest in the economic development of the British countries overseas. It seems opportune, therefore, to attempt to indicate the importance of the United Kingdom as a market for the fruits of the world, the part the Dominions and Colonies play in supplying this market, and any possibilities for further development.

The consumption of fruit in the United Kingdom is very large. There is the home production of the value probably of some £10,000,000. But this goes but a little way in meeting the demand. The United Kingdom is the greatest fruit-importing country in the world. The imports of fresh fruit alone amounted in 1931 to over £32,000,000, 28 per cent. being of Empire origin. Other categories, the most important being dried and canned fruits, edible nuts and fruit juices, brought the total to about £46,000,000. In round figures, therefore, the annual fruit trade of the United Kingdom is worth some £56,000,000.

How important fruit has become in the dietary of the nation, and how dependent we are on overseas supplies, is indicated by stating that in 1931 the value of our imports of fruit and fruit products (excluding wine) was equal to

that of butter, exceeded pigs and pig products by £4,000,000, wheat and flour by £12,000,000, poultry and eggs by £26,000,000, and was nearly three-quarters that of beef and mutton, including living animals.

The main features of the import trade in fresh fruit in 1931 are shown in Diagram I, based on data kindly supplied by the Empire Marketing Board.

To obtain these large supplies, and in particular to be able to enjoy several fruits throughout a large portion of the year, we make demands on many countries. The most casual glance at trade statistics [1] shows the widely distant sources of the fruits which reach these shores : oranges from the Mediterranean region, South Africa, United States, Australia and Brazil ; apples not only from Canada, the United States and South Africa, but even from so far as Australia, Tasmania and New Zealand. Our bananas no longer come mainly from the Canary Islands, but from Jamaica, Central America, with some from Brazil. Even such comparatively perishable fruits as grapes, peaches and pears reach us safely not only from Europe but also from South Africa, Canada and Australia. Now most of these fruits are not native to the countries whence they are exported. An enormous amount of activity has been displayed in introducing fruit-bearing plants throughout the world. Before rapid transport and efficient methods of storage were possible this was the only means by which the fruits native to one region could be enjoyed by the inhabitants in a distant country. The discovery of a new fruit, however attractive, by adventurous explorers resulted in no addition to their home dietary unless the plant bearing it could be introduced alive and induced to fruit in their own or some closely adjacent country.

The orange is an interesting example. Native, like other members of the citrus family, to the Indo-Chinese region, it reached the Mediterranean region many centuries ago and found there a very congenial home. The Spaniards carried it to the West Indies and Florida about 1600, and now Spain and the Southern United States are the world's greatest orange producers. But in England we find, until comparatively modern times, efforts being made to produce the fruit in special buildings, known as Orangeries, an

FRESH FRUIT

IMPORTS INTO UNITED KINGDOM, 1931

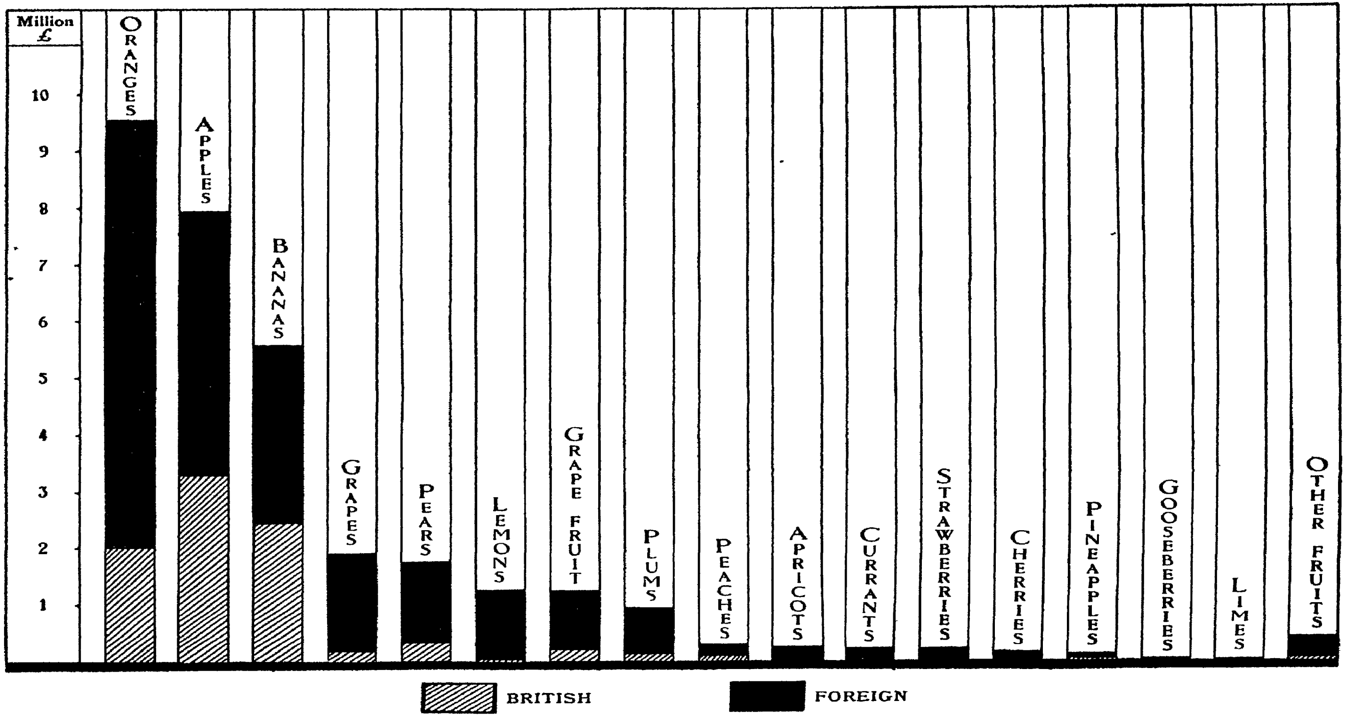

Diagram I.

example of which, but no longer containing orange trees, can still be seen at Kensington Palace.

Similarly the banana, also native of the East, became early known to Europeans ; it is stated to have greatly impressed the Greeks under Alexander the Great. The Portuguese introduced it to West Africa and the Canary Islands ; from the latter it was carried in 1516 to Santo Domingo to become, in due course, the source of the great Central American and West Indian industry, which now supplies both North America and Europe with most of their bananas.

Travelling in the opposite direction, the pineapple, a native of the tropical New World, has furnished the Azores and South Africa with an important crop, and enabled a country, so distant from its home as British Malaya, to become our main supplier of this fruit in the canned condition.

Much progress had to be made, however, before fresh fruits from the tropics or South Africa, to say nothing of Australia, could be transported to the United Kingdom on a commercial scale with reasonable hope of success. The position was the same for the Briton who went to dwell in the tropics and retained a desire for the fruits of the temperate regions. Much effort was often expended in attempting the cultivation of apples, pears, apricots, peaches, etc., particularly in the higher lands. It is interesting to note, as an instance of your long-standing interest in Empire fruit, that over 150 years ago the thanks of the Society were awarded to Mr. O. S. Brereton for communicating a letter from Mr. F. Samuel Kuckalm to the Hon. Daines Barrington [2]. In this letter from Kingston, Jamaica, dated October 12, 1781, Mr. Kuckalm refers to his hopes of having the first orchard of European fruit trees within the tropics and reports that he now " has peaches in high perfection, both in taste and size . . . also apples equally fine in taste, colour and size." He mentions various troubles and his hopes to surmount them so that in the future " I shall have the pleasure of sending you cyder made of the best of apples in Jamaica." In a postscript he adds " The Plantation is half-way up the Mountains."

Nowadays the Jamaica planter gets his apples with

much more certainty from North America, just as we get our bananas from Jamaica. This successful interchange of fruits between far distant countries is quite a recent development. Some of the steps by which success has been attained may be indicated by tracing the development of the world's trade in bananas and apples.

Transport at Low Temperatures

Before dealing with these, however, we must note the beginnings of the application of refrigeration as a factor in the successful long-distance carriage of fruit. In 1866 [3] this Society drew attention to a proposal to export grapes from Cape Colony to England with the assistance of *ice sent from Boston* (*U.S.A.*) to the Cape, and added in comment : "This enterprise in other quarters, thanks to the American ice trade, which tends to expand more and more, might start the idea of similar industries in all parts of the world, thus permitting Northern Europe, and especially England and France, to receive and taste all the delicious fruits with which tropical countries abound." The ice referred to was doubtless natural ice, which much later than this was imported in large quantities into the United Kingdom, mainly from Norway. The industrial use of artificial ice dates from about 1880 and before the end of the century we had reached the stage when ships could make their own ice, or employ other means for maintaining storage chambers at low temperatures. It then became possible to carry perishable products, not only fruits, but also meat, fish, butter, etc., in the fresh state for lengthy voyages.

With fruits, however, it is not merely a question of picking them ripe and then by cold storage preserving them in this condition. Fruits have to be kept alive under conditions in which they can still continue to breathe, and carry on the changes incidental to ripening, e.g. in the banana the conversion of starch into sugar. The aim is to reduce these activities so that the fruits ripen more slowly and thus can be carried for longer periods before they become over-ripe and begin to decay. At low temperatures the activities of injurious organisms, moulds, bacteria, etc., are

also reduced. The most suitable conditions of temperature, ventilation, etc., vary greatly for different fruits, e.g. apples carry well at about 32 to 35° F., oranges at 40°, pineapples at about 45°, bananas at about 53°, and so on.

Bananas

As is well known, the Canary Islands have a large banana industry, and the variety grown there, although Chinese in origin, is popularly called the Canary banana. Now the banana has been in the Canaries since, at any rate, about 1500, because in 1516 Friar T. de Berlanga took it thence to the West Indies. The Canaries are only about four days by steamer from England, yet we find that as comparatively recently as just 100 years ago the banana was evidently so little known in England that it furnished Lord Beaconsfield, travelling in the Near East, with "something to write home about." In a letter dated Cairo, May 28, 1831, to his sister he says: "Oh, the delicious fruit we have here and in Syria! Orange gardens, miles in extent, citrons, limes, pomegranates; but the most delicious thing in the world is a banana, which is richer than a pineapple."

The development of the banana trade from the tropics to temperate regions is well told in books by W. Fawcett [4] and P. K. Reynolds [5]. It began about 1804, with occasional consignments of a few bunches by schooners plying from Cuba to New York. In 1871 bananas were carried also by schooners from Jamaica to Boston, the trips taking about sixteen days. The following year the first shipment by steamer was made from Aspinwall (now Colon) to New Orleans, and soon steamers were also used from Jamaica.

The first commercial importations into Europe were small quantities from Madeira in 1878, and from the Canary Islands in 1882. About 1896 efforts were made to place Central American bananas on the European market, the fruit being carried from Costa Rica to New York and thence by the fastest available liners to Liverpool. This venture was not successful. The Canary Islands trade, however, grew, the voyage being short and cold storage unnecessary.

From 1899, as the result of the advance in methods of

refrigeration, and the establishment in that year of the subsidised Imperial Direct Service with specially equipped vessels, Central American and Jamaica bananas began to reach England in large quantities. These were of the Gros Michel variety, larger than the Canary banana, and better suited for carriage uncrated, stacked closely together in refrigerated and ventilated holds. The enormous expansion of this trade from 1900 onwards is shown in Diagram II. Within the last five years our importations from the Canary Islands have declined, due to diversion to the Continent. Also Brazil has become an increasingly important source of supply, sending us a banana of the Canary type but carried uncrated.

There are two recent developments of importance to the banana trade. Owing, in part, to the ravages of Panama disease (due to a soil-inhabiting fungus), which affects the Gros Michel but not, usually, the Canary banana, large areas of banana cultivation in Central America have been abandoned. Efforts are being made (*a*) to breed a banana of the Gros Michel type but immune, or highly resistant, to Panama disease, (*b*) to ascertain whether the Canary banana, after full investigation of the exact conditions necessary, cannot be carried satisfactorily without the expense of being crated. Researches are being conducted at the Low Temperature Station, Imperial College of Agriculture, Trinidad, with the financial assistance of the Empire Marketing Board. Reports on the progress are indicated in the appended bibliography [6].

Recent work in Australia indicates that the Canary banana ripens much more quickly, more evenly and with a better flavour if minute quantities of ethylene gas are used, as sometimes in colouring citrus fruit.

It can be said with reference to (*b*) that, as the outcome of the results already achieved, the planting community of Trinidad is seriously considering taking up again the production of the Canary banana as a crop for export under better conditions than were possible with its previous trade which ceased with the war [7].

The other question is an economic one concerning Jamaica, at present almost the sole British source of supply of bananas. The welfare of Jamaica is very largely de-

BANANAS

IMPORTS INTO UNITED KINGDOM

1900—1931

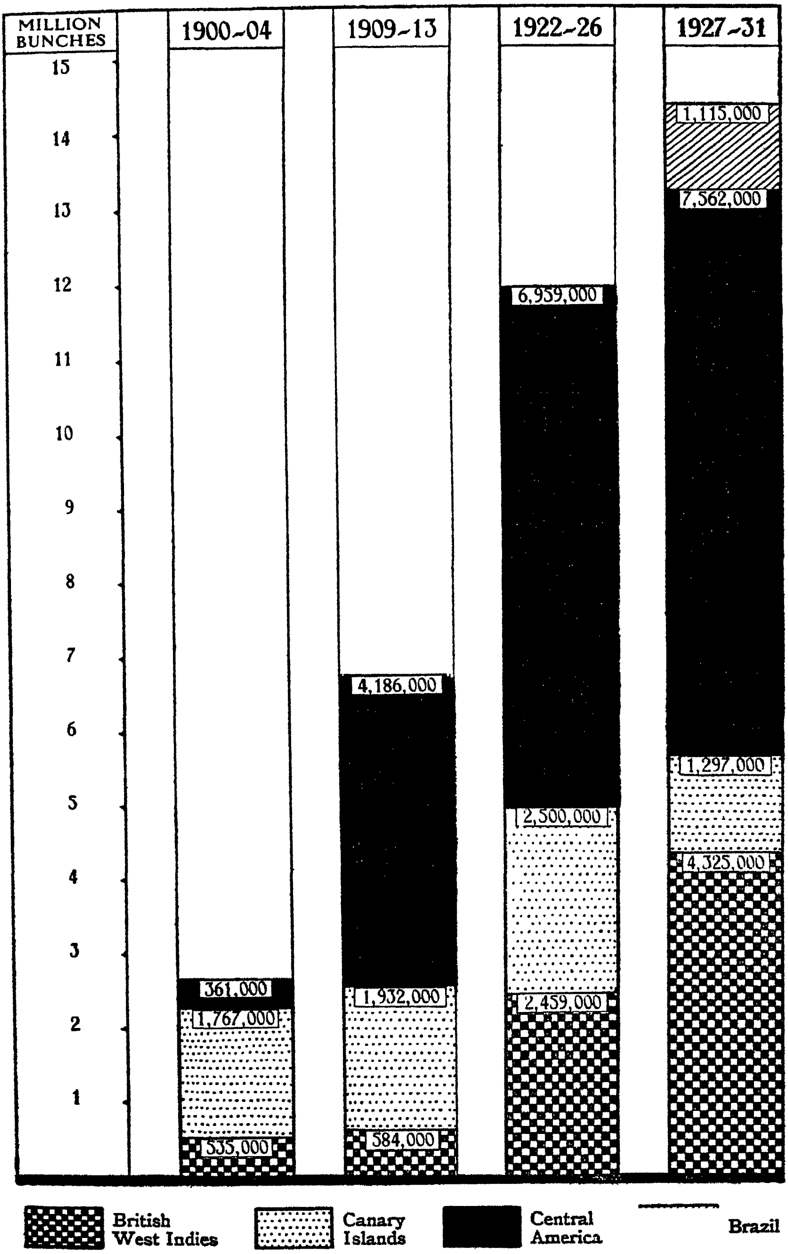

Diagram II.

pendent on bananas: last year 25,000,000 bunches were exported. Until recently, the shipping and marketing of Jamaica bananas has been, to quote Karl Walter [8], "practically a monopoly of the United Fruit Company, established by virtue of its efficiency, its controls of shipping, its large capital resources, and its command of alternative sources of supply." Various efforts to break the monopoly, including the Government subsidised service in 1899, and subsequent ones by the planters to market on their own account, failed. In 1929, however, the Jamaica Banana Producers' Co-operative Association was founded, with financial support from the Colonial Development Fund. As reported by Lord Olivier [9], the Association in January, 1932, comprised 10,407 members, with lands ranging from a quarter to over 1,000 acres, but 99 per cent. of whom do not own more than 50 acres. It has a fleet of five (and the sixth just launched) fruit and passenger ships plying to London and Rotterdam, and also loads the Canadian National Line steamers fortnightly, and one or more a week for the United States market. In 1931 the Association handled over eleven million "payable bunches" of bananas, approaching one-half of the colony's output. The history of the Association is a noteworthy example of the value of co-operation amongst fruit growers in a British colony, and well worthy of being followed in other areas where such organisations do not yet exist.

This is particularly the case with a fruit such as the banana. The day is past for casual small consignments. It is essential to have specially equipped ships calling at regular and frequent intervals. Sufficient fruit in exactly the right stage of maturity must be ready for immediate loading. The conditions during transport must be exactly controlled. An efficient organisation must exist for the handling, final ripening, and distribution of the fruit in the country to which exported. No light task when it is remembered that modern banana boats may carry up to 115,000 bunches at a time. It has been due to the high degree of efficiency attained in these various branches of the industry that the banana imports into the United Kingdom have grown from about 10,000 bunches in 1884 to over 16,000,000 in 1931.

Cannot some other Empire countries contribute to this huge supply, about 60 per cent. of which still comes from foreign sources ?

For the best results the voyage should preferably not be longer than sixteen days, but can be extended to twenty or even more. With the longer voyages the fruit has to be carried at a lower temperature, about 51° F. ; the final ripening up is then unduly prolonged and the result not so satisfactory. Trinidad, already referred to, and other suitable West Indian islands, e.g. Grenada, St. Lucia, are well within the time limit (13 to 14 days). On the other side of the Atlantic, Sierra Leone (9 days), the Gold Coast about three days more, and possibly also Nigeria are potential sources of supply. The first two of these colonies have already started to test possibilities by experimental cultivations. Encouragement is afforded by noting that French West Guinea (9 days) has had for some years an increasing trade in bananas to France, and recently supplies from the British Cameroons, more distant than Nigeria, are safely reaching the continent of Europe.

Apples

Apples are second in importance amongst our fruit imports, reaching an annual value of about £8,000,000, over 60 per cent. in some years coming from within the Empire.

The modern trade in apples serves to emphasise the progress made in the science and practice of fruit transport. Apples are now available all the year round. For some six months, October to March, the main shipments arrive from Canada and the United States, and for four months, April to July, from Australia, Tasmania and New Zealand owing to their reverse season compared with the northern hemisphere.

North America as a source of supply has the great advantage that the journey is comparatively short and the fruit is mostly carried during cool weather. From Australia, Tasmania and New Zealand not only is the voyage five or six times as long, but for the greater portion of it the conditions are hot. To quote a recent report of the

Empire Marketing Board [10]: "The annual shipment of several million boxes of fruit from Australia and New Zealand through the tropics to the European markets some 12,000 miles distant is perhaps the most impressive achievement of the fruit industry and one of the major triumphs of refrigeration. When the inherent difficulties of the undertaking are considered, the condition in which most cargoes are landed is surprisingly good. At times, however, serious wastage develops, both during shipment and in the later stages of distribution and marketing."

Much attention has been, and is being, given to the difficulties met with in transporting apples, by research workers not only in this country, but also in Canada, Australia, New Zealand, etc. This afternoon I can only call attention to one piece of work, which has yielded important practical results. It also affords an excellent demonstration of the point, previously stressed, that fruits are living organisms, and during transport must be treated as such and not merely as inert organic matter to be preserved from decaying [11].

About 1922 anxiety was caused in the trade by large losses in shipments of Australian apples due to "brown heart." The fruit was often apparently quite sound externally but uneatable due to internal decay showing first as brown discoloured patches and later as cavities lined with brown leathery tissue. The loss attributed to this cause in 1922 amounted to £250,000. Investigations at the Low Temperature Station, Cambridge, showed that such a condition could be induced by storing apples under badly ventilated conditions. In 1923 the matter was tested on commercial consignments by five members of the staff of the station who went to Australia and came home on different apple-carrying steamers. The conclusion reached was that brown heart was definitely traceable to a high percentage of carbon dioxide, and correspondingly low percentage of oxygen, in the ship's hold. In other words brown heart was indicative of the apples having been suffocated.

The amount of ventilation necessary depends on the temperature at which the apples are carried, because within certain limits, the warmer the apples the more actively

they respire. Thus it was shown that at 70° F. 50 cases (approximately 1 ton) of apples gave off 12 cubic feet of carbon dioxide a day, whilst at 35° F. the output was only 2·5 cubic feet. Moreover, in the process of respiration apples generate heat ; the more active their respiration the more heat they evolve. Now if a great stack of cases of apples are packed in a ship's hold during hot weather they may take a long time, up to 10 or even 20 days, to cool down to the best carrying temperature (32° to 35° F.).

During this period they are giving out more carbon dioxide, and also themselves generating more heat, than at the proper carrying temperature. Hence the importance of pre-cooling fruit for shipment, now commonly done. The practical benefit resulting from this investigation is shown by the following extract from the same E.M.B. [10] report for the years 1927–30. " The physiological injury, brown heart, was formerly responsible for very heavy losses in Australian apple shipments. . . . Cases of brown heart still occur occasionally, and in view of the large number of boxes affected in each instance, cause appreciable loss. Two shipments of Australian apples showing brown heart arrived during the period under review, one in 1927 and one in 1930. In both cases the injury was confined to one hold, but in these holds a high proportion of the fruit was affected."

A point of interest to the producer is the existence or otherwise of national tastes in apples. Dr. W. T. Macoun, Dominion Horticulturist of Canada, recently obtained information on this point from 172 countries, states, colonies, etc. [12]. The conclusion he reached was that " price, not variety, determines the popularity of an apple with the poor, who use the lower grades of apples more than do the upper and middle classes ; but who, apart from this, seem to appreciate a good apple when they get it as well as those who are better off, a red apple attracting the largest number of persons of all classes in practically all countries, China appearing to be nearly the only exception." In England " red colour for dessert and green for cooking are in greatest demand."

Peaches

Although our imports of peaches are comparatively small they afford an excellent illustration of the advantage, both to producer and consumer, resulting from modern methods having increased the distance such a fruit can be safely carried.

Before the days of refrigerated transport the only peaches obtainable in the United Kingdom were either home-grown or from adjacent countries such as Italy, France and Belgium. In consequence the peach season was comparatively short and there was little opportunity for Empire countries to send fresh peaches to the United Kingdom. Now scarcely a month passes but that some peaches are imported. (See Diagram III.) The main consignments, however, arrive in two well-marked seasons, January to March, South African, and July to October. European, mainly Italian. Even far distant Australia contributes a small quantity.

In 1930 the quantities from South Africa and Italy were approximately equal. In 1931 the South African supplies were small owing to hail storms at the flowering period, and during the summer there were larger imports from the U.S.A. Owing to their arrival at different seasons, the South African and Italian peaches do not compete with each other, and the home consumer is able to enjoy this fruit through a much greater part of the year.

Oranges

As shown in Diagram I, oranges are the most important of our fruit imports, reaching in 1931 the value of approximately £10,000,000, about one-quarter being of Empire origin. The United Kingdom is the largest importer of oranges, taking between 30 and 40 per cent. of the world's total export trade.

The principal orange-producing regions lie in two belts between approximately 20° and 40° latitude on both sides of the equator, i.e. the orange of commerce is mainly a sub-tropical crop. The northern zone is by far the most important, the two principal orange-growing countries being Spain and the United States, whose production is

PEACHES

MONTHLY IMPORTS INTO UNITED KINGDOM

1931

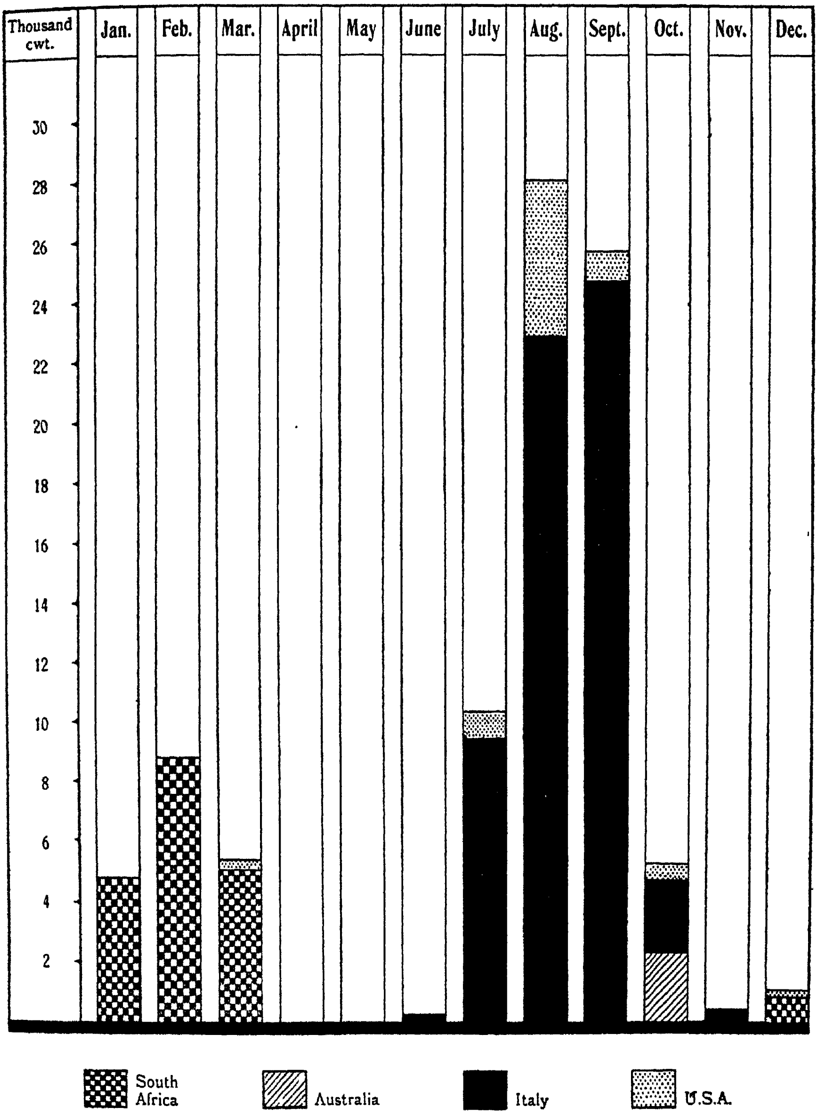

Diagram III.

about equal. As exporters, however, their position is very different. In Spain the domestic consumption is comparatively small, in the United States of America it is very large, so that whilst the United States furnishes only some 7 per cent. of the world's total export trade, Spain supplies about 60 per cent. The other most important exporting countries are Italy 12 per cent., and Palestine 7 per cent.

In the British Empire, in addition to Palestine, there is a large and increasing export from South Africa ; the West Indies (Jamaica) and Cyprus also export. Australian oranges are mainly used locally. Of recent years Brazil has largely increased its exports and Argentina is following suit.

The much wider area from which our imports of oranges are now obtained, including countries north and south of the equator with crops ripening at different seasons, has made oranges available through a much longer period. One need not have a very long memory to recall that oranges used to be scarcely worth eating much before Christmas because they were too sour, or after about March because they were lacking in juice. Now oranges of good quality are available throughout the year. As shown in Diagram IV of our monthly imports for 1931, the main supplies are naturally received between December and May or June when the Spanish and Italian arrivals are greatest. In the summer months the demand is less owing to the availability of other, including home-grown, fruits.

Considering the Empire contributions, the diagram indicates that these are mainly from Palestine and South Africa in two well-defined seasons so that they do not compete with each other. The Jaffa oranges from Palestine are of a special quality which hold their own and command a comparatively high price on their merits. The West Indian oranges, also available during the winter months, although excellent, commonly, like oranges of other humid tropical countries, lack the attractive colouring of oranges grown in drier regions, and have usually a coarser "rag" (the internal skin-like partitions). Accordingly they would have to compete in price with the Spanish oranges, which is impossible, with profit, owing to the cost of their much longer journey, in cold storage,

ORANGES

MONTHLY IMPORTS INTO UNITED KINGDOM

1931

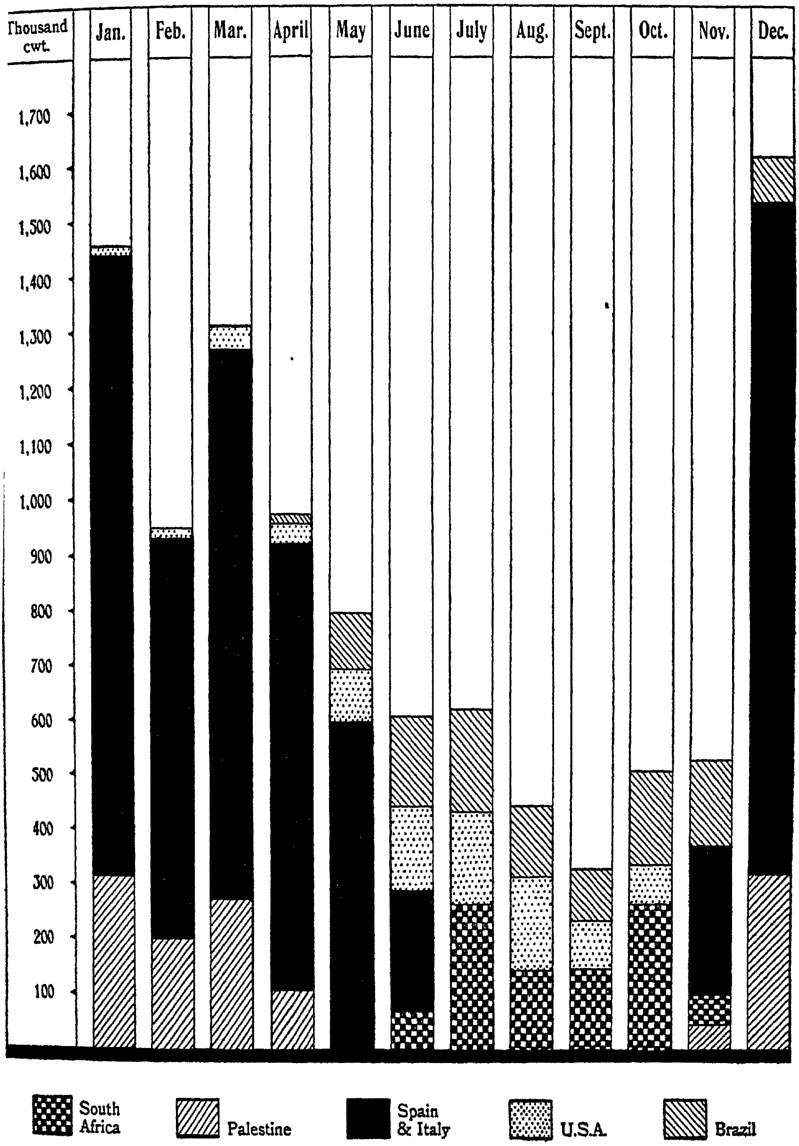

Diagram IV.

compared with the short trip without the need for refrigeration from the Mediterranean.

As the Palestine supplies fall off, those from South Africa begin to arrive, good-class fruit fetching the higher summer-season prices in competition largely with supplies from Florida and Brazil ; Argentina will also probably become of more importance in the future. With oranges, transport troubles are fewer than with apples. Waste due to blue and green moulds can be large, but is largely controllable by proper care in picking, packing and handling, in which respect Palestine and Spain have not yet reached the high standard of the United States and South Africa. Temperature control in transport is important, the orange carrying best at about 40° F. compared with 32° to 35° for apples and about 53° for bananas.

Grape Fruit

Within the last ten years the consumption of grape fruit in the United Kingdom has increased enormously ; from 21,000 cwt. in 1921 to no less than 900,000 cwt. in 1931. The Empire contribution to this total is as yet comparatively small, but is growing and should continue to do so provided proper care is taken in the producing countries. The grape fruit thrives under rather more humid tropical conditions than the orange. The principal producing regions of the world are the Southern United States and the West Indies. South Africa and Palestine have also large and expanding industries.

As regards Empire trade to the United Kingdom an important point is that there are no large supplies forthcoming from Spain and Italy with the advantage of short and inexpensive transport. Empire and foreign grape fruit all have to come long distances under refrigerated conditions and so compete on more or less equal terms.

As shown in Diagram V, Empire grape fruit arrive in two well-defined seasons : from the West Indies and Palestine during the winter, and from South Africa during the summer.

The United States supplies, which at present dominate the market, come mainly from Florida, Cuba and Porto

GRAPE FRUIT

MONTHLY IMPORTS INTO UNITED KINGDOM

1931

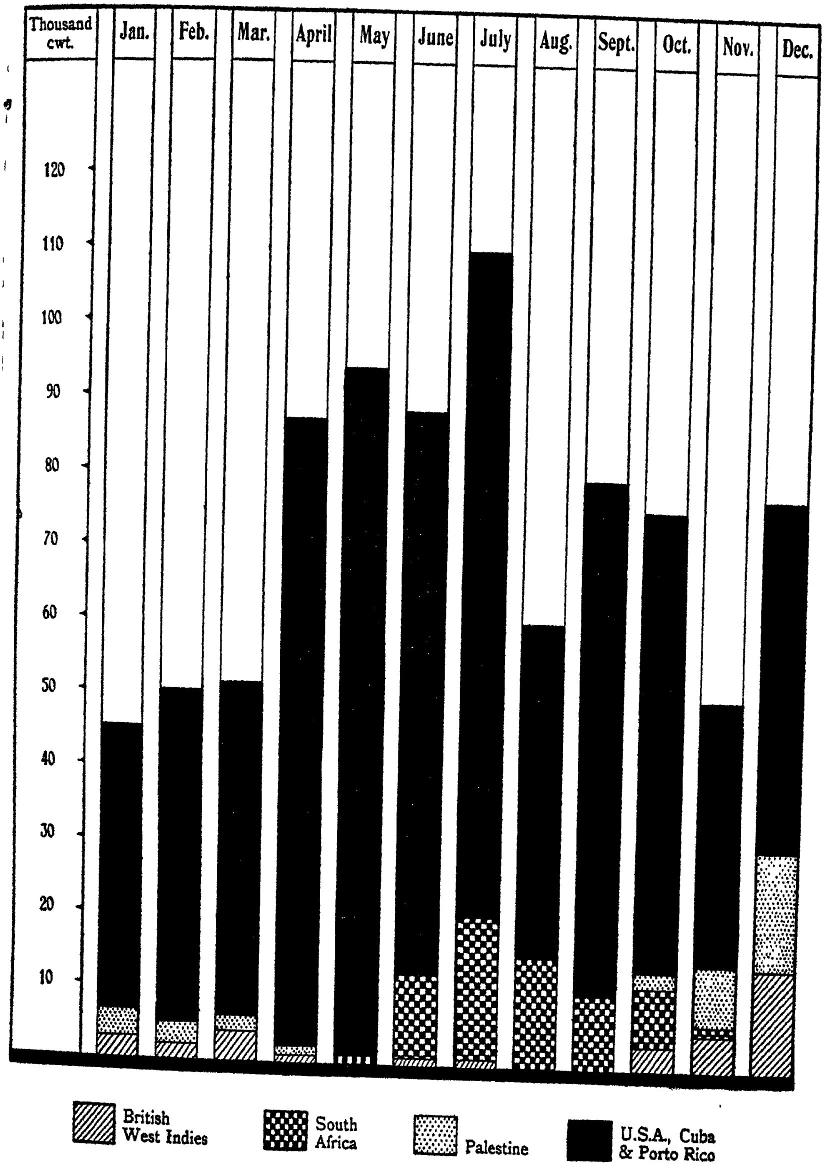

Diagram V.

Rico. Due to climatic variations, and in some areas two or more cropping seasons per annum, ripe fruit is available all the year round.

In the opinion of Professor H. Clark Powell [13], who recently visited and reported to the Empire Marketing Board on the actual or potential grape fruit growing countries of the Empire, " a considerable expansion of grape fruit production in British Honduras, Jamaica and Trinidad is fully justified." He bases his opinion on the ground that these colonies can produce fruit of good quality and put it on the United Kingdom market at a lower cost than the U.S.A., Cuba or Porto Rico. At the same time Professor Powell points out lower cost alone will not suffice. The success of the United States has largely been due to the confidence gained by various well-known brands for uniformity and quality. Unless the West Indian colonies put on the market " fruit equal to them in every respect the public will continue to demand the higher-priced fruit." Both Jamaica and Trinidad have taken steps to attain this end. Jamaica, previously an exporter, founded in 1930 a Citrus Growers' Association, with a well-equipped packing house which has already secured a great improvement in the standard of exported fruit. Trinidad, which after several years' work laying the foundations of the industry, has now reached the exporting stage, has also its Co-operative Citrus Growers' Association, with a central packing house and strict supervision of exports. In both colonies the aim is to secure the bulk shipment of fruit under definite brands which can be relied on for quality and uniformity in grading and packing. These points are of the utmost importance, because, as previously mentioned, the time is past for casual consignments into a highly competitive market of fruit not properly graded, packed and marked.

Elsewhere in the Empire, grape fruit would appear to offer opportunities for a new industry in West Africa, e.g. Sierra Leone and the Gold Coast. The question is already receiving attention. It has to be borne in mind that grape fruit requires more care and skill, particularly in handling, packing, etc., than most present West African products, and very careful supervision would be necessary.

Lemons and Limes

These two citrus fruits are largely used for flavouring, the preparation of drinks, and as sources of citric acid. The lime is thoroughly tropical in its requirements, but the lemon, although it will grow in the tropics, does not do very well there, but flourishes under drier and less hot conditions such as in the Mediterranean region.

In the United Kingdom there is a large demand for lemons, probably due to custom and taste. To meet this the Empire's contribution is almost negligible, although South Africa and Palestine send some. Italy produces almost all our requirements. Our very modest demand for fresh limes is practically all met from the West Indies, which also supply lime juice. Efforts have been made in the past to popularise limes in this country, but little success has resulted.

Dried Fruits

To deal briefly with the other categories of our imports, dried fruits, about £5,000,000, are one of the most important. Although, as seen in Diagram I, the Empire contributes but a small proportion of the fresh grapes imported, the position is much better in respect to dried grapes in the form of currants, raisins and sultanas. Australia has built up an important industry in these products, amounting to nearly £2,000,000 in 1931. From South Africa we receive considerable supplies of dried prunes, plums and apricots.

Fruit Pulp and Fruits canned without Sugar

Most of the soft fruits, e.g. strawberries, raspberries, currants, etc., are not suited for long-distance transport even under the best available conditions, and as the overseas temperate regions of the Empire are all far distant we cannot expect them from these sources. In addition to home produce and supplies in the fresh state from adjacent European countries, there are large imports as pulp. The Empire as yet supplies but little of these products, amongst the most important items being raspberry and black-currant pulp from Tasmania.

Another important import is citrus peel (lemon, orange and citron) in brine, for use in the candied peel industry. Italy is the main source, supplying some 10,000 tons per annum. There might well be an opportunity here for some Empire countries, e.g. the West Indies or South Africa, possibly combined with commercial utilisation of the juice.

Canned Fruit (with Sugar)

The last twelve years have been marked by a great change in the imports of canned fruit. Up to then they were mainly pineapple, but in 1919 the imports, mostly of other fruits, suddenly increased enormously and, with some sharp fluctuations, have maintained a definite upward trend. The value of canned fruit imports is now about £6,000,000 per annum.

In pineapples, imports about £1,000,000, the Empire is predominant, over 80 per cent. coming from British Malaya. As regards the other three canned fruits most in popular demand—peaches, pears and apricots—the Empire contribution is under 10 per cent., the balance being almost entirely from the United States of America.

Sir Edgar Jones, Chairman of the Empire Canning Council, dealt very fully with the subject in his lecture to this Society in 1930 [14]. Developments are taking place both at home and overseas as the result of which canned Empire fruits should become increasingly important. The exhibits indicate the variety the Empire is already producing. One result might well be to place certain tropical fruits which do not travel very well fresh, but are very good when canned, e.g. mangoes and guavas, within the reach of the home consumer. There are opportunities here for the West Indies and other tropical colonies which have supplies of good-grade fruit.

From the point of view of the producer of a perishable product such as fruit, canning is of great economic importance as it helps to stabilise prices. Only too frequently a grower finds that when prices are high he has but little fruit to sell, whilst when he has a bumper crop the price obtainable may be so low as scarcely to meet the cost of picking and marketing. Also, for example with grape

fruit, there is always a considerable proportion of fruit unsuitable for export, although quite sound. It may be of wrong size, blemished externally or too ripe for long transport. A cannery in connection with a packing house will save such fruit being wasted. It is interesting to note that the new Jamaica Citrus Growers' Association has already made its first shipment of canned grape fruit.

Some Other Tropical Fruits

There are a few fruits, mainly tropical or sub-tropical, which call for brief mention, because of their interest rather than their commercial importance so far as the United Kingdom is concerned.

The custard apple, passion fruit (or granadilla), persimmon, litchi, etc., make pleasant novelties, but are not likely to meet with any very great demand, even if they could be sold considerably cheaper than at present.

The mango is in a different category. The good mango ranks amongst the best fruits of the world. Unfortunately many varieties do not carry very well, being apt to deteriorate rapidly on removal from cold storage, so that the loss during distribution and display in fruit-stores can be very high. A mango must be eaten when exactly right or it is worthless, which is not so with the apple, banana, orange or grape fruit. The same is true of that excellent fruit, used, however, mainly as a salad, the avocado, which also requires extreme care in transport and deteriorates very rapidly. This does not mean that good mangoes and avocados cannot be seen in this country, e.g. the South African "Sabre" mango, but that, pending improvement in the technique of transporting and handling, they will remain comparatively expensive luxury fruits.

Another tropical fruit scarcely known here is the sapodilla. Experimental shipments recently made from Java to Amsterdam are reported to have been successful, the fruit being sold at a satisfactory profit. Some of the West Indies, e.g. Tobago, have excellent varieties of the sapodilla available already in moderate quantity.

The mangosteen is another very delicious fruit, thriving only in thoroughly moist tropical conditions, e.g. in

British Malaya where it is native. Some forty years ago "it being reported that the mangosteen was almost the only fruit worth eating which Her Majesty Queen Victoria had never tasted" some were sent her from the Royal Botanic Gardens, Trinidad [15]. In a letter of acknowledgment dated Buckingham Palace, October 12, 1891, Sir Henry F. Ponsonby wrote, "I am commanded by Her Majesty to thank you for these mangosteens, and I may add that the Queen says at the same time 'they were quite excellent.'"

Edible Nuts

Although we spend some £3,000,000 a year on edible nuts (not including ground-nuts and coconuts), the Empire share in the trade is very small. Time will not allow us to deal in any detail with this group of products to-day. The possibility of greater Empire production of almonds, walnuts, Brazil and Sapucaia nuts, is worth consideration in the countries where they will thrive, also the greater utilisation of cashews. The production of the Queensland nut (*Macadamia*) is being encouraged in Hawaii. Its extremely hard shell presents a problem for the plant breeder.

Fruit Juices

The value of fruit juices imported is approximately £250,000, the most important being lime juice from the West Indies. Of recent years great advances have been made, largely the result of research work in the United States in the utilisation of other citrus juices. Examples of some of these products of Empire origin are exhibited. The cost of transport in the bottled condition is often prohibitive and efforts are being made to find practical methods of shipping in bulk, e.g. in a frozen condition, as from New Zealand.

Some of these juices will be of value not only for drinks, but as constituents of fruit salads, etc.

Conclusion

We will end this brief sketch with a few words on future possibilities. Stress has already been laid on the fact that

the modern fresh-fruit industry is a highly competitive one, presenting to the newcomer special difficulties due to the perishable nature of his produce. To make a success in exporting fruit to a distant country the following are essentials.

The producing country must possess suitable climatic and other natural conditions, have an adequate supply of skilled labour, a sufficiently frequent service of properly equipped ships, and reasonable loading facilities. The fruit grown must be of the proper commercial variety, and put up for export correctly graded, packed and marked.

The departments of agriculture and horticulture in the Dominions and Colonies by experimental and advisory work give great assistance to the producer on many of these matters.

Next, the producer or his representative must have knowledge of the market to which he is exporting, e.g. the fruits required, seasonal variations in supply, demand, price, etc. Means for the distribution of the fruit are very important ; one centre may be glutted whilst there is a good demand elsewhere.

All this requires efficient organisation in both the producing and importing country. Producers' associations selling in bulk through a reliable agent, under one or more definite brands, have great advantages including that of being able to advertise their produce. Well-known examples are those of the United States, some of which are bodies of world-wide influence. Such associations are becoming increasingly important in the Empire, and some instances of recent developments have been given. Others, even more important, might have been mentioned, e.g. the New Zealand Fruit Growers' Federation. Sound advice on co-operative production and marketing can be obtained from the Horace Plunkett Foundation, London. When useful information can be gained by small trial shipments, assistance is available through the Empire Marketing Board and the Cambridge Low Temperature Research Station, which has a laboratory at Covent Garden for dealing with such consignments.

The United Kingdom is well supplied as regards variety of fresh fruits, and there are no new ones which appear

likely to become commercially important in the near future. There may, however, well be opportunities for increased supplies from Empire countries, both those which already send fruit and others. The new tariff will doubtless help some countries. The West Indies might go far towards providing all the bananas we can take; and, in conjunction with South Africa, Palestine and Australia, in increasing materially the proportion of grape fruit received from Empire sources. Similar encouragement may be given to Empire apples, oranges, etc. There are undoubted opportunities also for West Africa—Sierra Leone, the Gold Coast, and probably Nigeria—with bananas and grape fruit amongst major, and pineapples amongst minor, products; lemons are also being tested in Sierra Leone.

Canning offers big possibilities, considering how small a part, excepting with pineapples, the Empire has as yet in this important and growing industry; also with pulp, dried fruits and possibly nuts. More attention could well be given to the commercial utilisation of fruit by-products; fruit juices, peel for the candied trade, etc. In Hawaii, even pineapple peel and cores, waste products in the canning trade, are converted into a feeding stuff known as pineapple bran.

It must be borne in mind, too, that the opportunities in Europe for British countries overseas are not limited to the United Kingdom market. Several European continental countries are also very large fruit importers, and, owing to recent improvements in the distributing organisation, more Empire fruit is finding a market there.

The possibilities for the home producer cannot be dealt with shortly, even were I qualified to do so. My main task this afternoon has been to attempt to indicate the great importance of the United Kingdom—the greatest fruit-importing country of the world—in relation to the Dominions and Colonies, the wonderful progress our fellow countrymen overseas have already made in supplying our wants, and some directions in which still further progress may be made to the benefit of the Empire as a whole.

Finally, I wish to express my thanks for specimens and other assistance to the Trade Commissioners of Australia, Canada, New Zealand and South Africa; the Malayan

Information Agency; Major E. G. Monro, of Covent Garden; and Mr. T. W. King, C.B.E., of the Civil Service Supply Association; also to Miss Cullum for the preparation of the statistical diagrams.

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SUGAR-CANE MOTH-BORER (*DIATRÆA*) INVESTIGATIONS IN ANTIGUA

THE following progress report for the year 1931, by Mr. H. E. Box, the Entomologist appointed under a grant from the Colonial Development Fund to study sugar-cane moth-borer problems in Antigua, has been furnished to the Imperial Institute by the Colonial Secretary, Leeward Islands.

The writer's official appointment commenced on March 22, 1931. About two weeks (March 22–April 6) were spent in Trinidad on duty, investigating general conditions there

in collaboration with Dr. J. G. Myers. Special attention was given to the distribution of the various species of *Diatræa* in sugar-cane, corn and other cultivated grasses, as well as their numerous wild hosts belonging to the same group of plants. Several species of grasses hitherto unknown as hosts of *Diatræa* were found infested, and the discovery of the food-plant and habitat of the previously little known *Diatræa bellifactella* was made, together with observations on some of its natural enemies. Visits were made to the chief cane-growing districts, as well as to savannah and mountain-forest, and observations made on ecological conditions in these regions which have proved of inestimable value to the course of investigations in Antigua.

During the voyage from Trinidad to Antigua, made in company with Dr. Myers, a visit was made to Barbados (two days), where the work of Mr. R. W. E. Tucker, Government Entomologist, was demonstrated; trips were made to various sugar-estates, on some of which very heavy infestations by *Diatræa saccharalis* were observed. At Grenada, St. Vincent, St. Lucia, Dominica and Montserrat, short visits were made to areas where sugar-cane is grown, and an idea of general conditions gained. Some important results were secured from these visits, relating especially to the discovery of species of *Diatræa* previously unknown from certain of the islands, and the prevalence of *Diatræa* spp. in wild grasses. Most of these observations have been incorporated by Dr. Myers in a scientific publication which is now in the press.

The writer's duties in Antigua commenced with his arrival at St. John's on April 11, 1931. In the following pages a general account is given of the work accomplished and the lines of investigation developed, but time and space do not permit of the inclusion in this report of all the quantitative data that have been obtained, though it is hoped to publish some of the results shortly.

The first ten days were spent largely in company with Dr. Myers in a general inspection of the island and in discussing its biological relations with the other parts of the Caribbean area which had been visited by both of us.

It may be stated here that the reason why Antigua was

selected by Dr. Myers as a site for investigations into the cane moth-borer problem is because of the comparatively simple ecological conditions as compared with British Guiana, where the investigations are to be duplicated by Mr. L. D. Cleare, Government Economic Biologist, with the aid of the Colonial Development Fund. In this way it is hoped to learn more of practical value by a comparison of these extremes than could be secured were the investigations carried out elsewhere.

In Antigua but one species, *Diatræa saccharalis* (Fabr.), is known to occur. This feeds indiscriminately upon sugar-cane and corn (maize), leaving aside for the moment the other food-plants that have since been discovered. Insect parasites are known to attack only one stage of the insect, viz. the egg, from which *Trichogramma minutum* and *Prophanurus alecto* had been reared previous to the writer's arrival; the former is extremely abundant, whilst the latter has not yet been encountered by the writer. The fungus parasite, *Cordyceps barberi*, attacks probably a greater proportion of *Diatræa* larvæ in Antigua than in any other country where it occurs.

Preliminary observations on early larval mortality were started by the writer shortly after his arrival and have been followed up during the year, with the result that Dr. Myers' statement that over 90 per cent. of the larvæ hatching from eggs perish before they have done any damage to the crop has been amply confirmed. Actual figures on this aspect have been secured from examinations of cane-stools in several distinct areas, and in one instance the mortality figure on over 250 eggs which had hatched normally was 100 per cent. These results, combined with Dr. Myers' observations on this subject and what has been published in regard to the closely related European Corn Borer (*Pyrausta nubilalis*) in North America, have caused the writer to modify his earlier opinion to the effect that control of *Diatræa* in cane-fields was possible by means of artificially reared egg-parasites (*Trichogramma*).

Examinations of canes of all ages have been made with a view to estimating the prevalence of *Trichogramma* in Antigua; this work has been carried on throughout the period under review. In some fields the data thus secured

have been used as a basis for comparing the infestation by *Diatræa* at harvest, but so far no significant correlation has been observed. Certain fields that were examined in May and June and found to have a high *Trichogramma* population and relatively high percentage of parasitism have been found to be just as highly infested at harvest as those characterised by an almost complete absence of egg-parasites earlier in the year. One field with an unusually heavy infestation by borers was examined in December (pre-harvest examination), and found to have an average of four *Diatræa* eggs per leaf (average of 105 leaves per cane-stool), of which only 86·3 were parasitised ; yet the *Trichogramma* population amounted to over a million and a half per acre without artificial rearings. Conversely, other fields with a low percentage of *Diatræa* infestation have been found to have an extremely low *Trichogramma* population as well as a low percentage of parasitism. It will be noted that the parasitism of 86·3 per cent., with a superabundance of eggs available, is still significantly less than the 90 per cent. mortality found even where *Trichogramma* is completely absent. Just how far the two factors overlap required careful investigation, but it can be stated that as a result of investigations it has been shown that in no case can a low percentage of borer attack be attributed to a high percentage of parasitism by *Trichogramma*. A small experiment was conducted in a 9-acre plot of isolated canes near Falmouth ; the field was examined in May and found to have a very great number of eggs of *Diatræa* present, some individual stools with as many as fifteen egg-clusters (the average number of eggs per cluster being around 11·5) ; it became evident to the writer, after careful examination, that *Trichogramma* was not present in this field, all the egg-clusters found—many hundreds—being unparasitised. Though a large number of the eggs had hatched normally, very few live borers were found. Later the writer placed in two rows fifty parasitised egg-clusters which had been collected from the north of the island ; three weeks after this liberation, practically all of the egg-clusters were found to be parasitised, on many stools 100 per cent. of them, yet to-day this field is as heavily attacked with *Diatræa* as it could be. No control plot was available,

and indeed controlled experiments of this nature are extremely difficult to secure, but the results of the year's work have already convinced the writer that the effects of *Trichogramma* in controlling *Diatræa*, as recorded by numerous authors (including himself), have been unduly exaggerated because of lack of fundamental data as a basis for conclusions.

When the writer commenced the examination of fields in Antigua, the 1931 crop (the lowest in the history of the Antigua Sugar Factory, Ltd.) was almost finished ; nevertheless, the opportunity was taken to make a number of examinations of canes at the loading stations distributed throughout the cane-growing area, with a view to gaining an idea of the prevalence of borer attack. Twenty-one examinations were made, and it was found that 924/1,490 or 62 per cent. of the stalks were bored, the joint infestation being 3,830/29,271, or 13·1 per cent. ; the intensity index (number of bored joints per bored cane) was 4·1 ; this degree of infestation may be considered serious. It must be borne in mind, however, that this does not represent the average for the crop, but only of a number of estates whose canes were cut in May, consisting largely of ratoons, known to be comparatively less attacked than plant canes. Neither can the conditions be considered as representative for the time of year, since this particular crop was harvested after one of the most serious droughts in the history of the island.

From the beginning of December onwards detailed counts of the infestation of representative fields—for early harvesting—have been made all over the island. This work is being done in collaboration with Mr. M. Moore, Chief Chemist of the Antigua Sugar Factory. Samples of canes from each field are examined and counts made on the stalk and joint infestation by *Diatræa* ; simultaneously, the quality of the juice, indicated in degrees of Brix, is taken by Mr. Moore on the bored and unbored canes (and frequently on the bored and unbored joints on the same canes), as well as the real average for the field. Thirty-eight fields, representing plant and ratoon canes of the standard varieties, have been thus examined during December 1931–January 1932, and whilst the

results properly belong to a report on the year 1932, the following figures which have been secured are worthy of mention.

	Per cent.
Percentage of stalks bored (all fields)	72·8
,, ,, joints bored (all fields)	16·0
Plant cane, 19 fields, stalks	76·5
,, ,, ,, joints	17·7
Ratoon cane, 6 fields, stalks	48·7
,, ,, ,, joints	7·8

The reason why full data are only available on twenty-five fields is that at the time this report is being prepared, calculations are incomplete, but the additional data will not materially alter the figures given, which have been shown by Mr. Moore to represent a loss of 3·7 per cent. of sugar in the case of plant cane and 2·1 per cent. in the case of ratoons ; on a basis of a 3·25 per cent. loss for all cane, the Antigua Sugar Factory loses £7,875 this year (calculating sugar at £10 per ton) on reduction of sucrose in juice through borer attack. This does not take into account the additional loss in quantity of juice per given weight of cane and the losses in the field due to the death of numerous canes and the loss in weight of others. Some fields very heavily attacked (stalks, 100 per cent. ; joints, 52 per cent., for example), already show a dead loss of up to 33 per cent. of the canes—which never reach the mill. The most conservative estimate of the losses sustained in this presidency during the 1932 crop through the agency of *Diatræa* is in the neighbourhood of twelve thousand pounds sterling.

With the commencement of the harvest, an attempt will be made to calculate exactly the field and factory losses through borer.

The chief experiments outlined in the research programme involve the comparison of various factors with adequate controls, the results to be compared with precisely similar experiments to be conducted in British Guiana by Mr. Cleare. The writer had not been long in Antigua before he recognised a difficulty in securing this aim, viz. the extraordinary heterogeneity of individual cane-fields, in which, due to the practice of continuous replanting or supplying, canes of all varieties and ages are

indiscriminately mixed. Following the Farquharsonian doctrine of scientific work in the tropics, the writer has for many years made a special study of agricultural conditions as applied to sugar-cane cultivation, and determined to ascertain the cause of the state of affairs in Antigua and remedy them if possible. The cause was immediately found to be due to various fungous diseases and unsound agricultural methods, and not entirely to erratic weather conditions, as supposed by the planting community. At two successive meetings of the Agricultural and Commercial Society held at St. John's on May 8 and June 12, respectively, the writer laid his views before the planters, which were received with interest by the more progressive element and a storm of opposition on the part of the more conservative. However, constructive criticism was the policy followed and from numerous plantings that have since been made results have followed sufficient to cause the leading planters and several others to improve their cultivations by proper selection and disinfection of cuttings and changing the method of planting the canes. In every instance during the 1931 planting season where the recommendations made by the writer have been put into practice properly, the results are incomparably better than those secured by the old traditional methods, and some of the fields show stands of cane fully established within six weeks from planting, resulting in a uniformity hitherto unprecedented in the estates concerned. Where the old method is continued, with few exceptions there is no better germination than was obtained in the 1930 plantings, when drought was alleged to cause the failures; yet the 1931 planting has been carried out under abnormally favourable conditions, so far as rainfall is concerned.

The question of planting canes *flat*, with a pick or a fork, instead of vertically or slanting, with the ancient and traditional "drill," has occupied the writer's attention, since such practice is intimately connected with the primary infestation of fields by *Diatræa*. Another agricultural matter that has been investigated is that of the distance of the plants in the row, the general custom in Antigua being to plant the canes (in the writer's opinion) much too far apart in the row; this has automatically involved the

question of abandoning the old "cross-hole" system in favour of furrow planting, a question of considerable importance now that the Gyrotiller is working in Antigua. The number of cane-stools in any area is an important matter in connection with borer attack, since, theoretically, with wide spacing the infestation by a given borer population is much more concentrated than where closer spacing is practised, resulting in more damage to the individual stalks.

The disadvantages of mixing different varieties in one and the same field are obvious, as also those attending the practice of supplying a field seven or eight times, often with heavily infested cuttings. The time of the year in which the canes are planted has also been questioned, and experimental plantings have been made on some estates which promise interesting developments.

For many reasons it is desirable to secure good ratoons as well as satisfactory crops from plant cane, not least among which is the well-established fact that ratoons are (other things equal) considerably less attacked by *Diatræa* than plants. To promote by every possible means long-ratooning—consistent with estate economics—is the policy advocated by the writer, and this depends primarily upon drainage, tillage and freedom of the fields from disease-producing organisms ; the natural resistance of the plant to disease can follow as a corollary when healthy, good cuttings only are used for planting the fields. There is no doubt whatever that much of the losses attributed to drought or heavy rains can be reduced when proper attention is given to sound agricultural practice, as will undoubtedly be evidenced when the 1933 crop is harvested on some properties.

A feature noticeable in Antigua to one who has visited other cane-growing countries, and which was mentioned by Dr. Myers in his Preliminary Report, is the large number of cane varieties grown on a commercial scale ; their distribution, however, does not always coincide with the conditions to which each is best adapted. Attention to the reaction of different varieties to *Diatræa* attack has been given, it being found that P.O.J. 2878 and P.O.J. 2725 are (apparently) far more susceptible than the standard Barbados seedlings grown throughout the island. It is

planned to carry out detailed experiments to determine as accurately as possible the effects of *Diatræa* infestation on the chief cane varieties grown in Antigua.

Perhaps the most serious menace to cane cultivation in Antigua at the present time is the complex of troubles broadly referred to as Root-disease, symptoms of which are present in almost every cane-field ; often the effects are little less than alarming, but characteristically enough, are attributed to adverse weather conditions, or to " grubs." Though neither a cause nor an effect of *Diatræa* attack, root-disease has had to be taken into account in the main investigation because of its effect on field comparisons. Canes which are stunted and whose leaf-sheaths are bound to the stalk by a matting of fungous mycelium are rarely attacked by borers, and therefore figure among the un-bored canes in quantitative work ; such canes, however, cannot be compared legitimately with sound un-bored stalks free from root-disease. Root-disease is, in the writer's opinion, the chief cause of the failure to secure good ratoons in Antigua ; its control is a matter more agricultural than mycological, since the symptoms rapidly disappear when a field is properly tilled and drained. Advice on the subject has been given to the planters.

The *Diatræa* problem can be regarded as but one strand in a complicated network of interacting biotic factors. No real progress could be made in the purely entomological aspect without taking into account fully the numerous other conditions (agricultural, meteorological, mycological, etc.). The need for an early concentration on the latter will be manifest to one conversant with the requirements of the problem.

Considerable data have been secured on the effects of corn (maize) on *Diatræa saccharalis*. This crop is rarely exempt from borer attack, but, like sugar-cane, appears to suffer more when grown on estates than when planted as peasants' crop. Corn-stalks have been found to harbour far more borers than individual canes, and more borers seem to reach maturity in corn than in cane, in any given area ; these preliminary observations require confirmation by means of controlled experiments, to be conducted next year. There is no doubt, however, that the practice of

growing corn between the rows of canes and allowing the old corn-stalks to dry out in the field is to encourage borer infestation in the canes. Actual counts have been made on the number of empty pupæ of *Diatræa* found in these old corn-stalks, correlated with the number of borers found in the adjoining rows of canes. On the other hand, experiments are now commenced to determine whether young corn might serve as a trap-crop for the first generations of *Diatræa* appearing in cane-fields.

Antigua differs from all the other West Indian colonies of similar area in the extraordinary diversity of its soil and climatic conditions, and it was one of the main items on the research programme to determine the effect, if any, of these variations on the prevalence of *Diatræa*. Certain figures obtained by the writer at the close of the 1931 crop suggested that there was a significant difference in the infestation of canes in the wetter as compared with the drier parts of the island; it is possible that these conditions were accentuated through the 1930–31 drought, but the more exact figures secured on the 1932 crop indicate that there is practically no variation in infestation according to the geographical situation of the estate concerned, but enormous variations in the infestation of individual fields on one and the same property. Why this should be the case is not at first apparent, but the problem will be solved by an intensive study of all the fields on one or more representative estates. This does not mean that a general survey of the island at each harvest is unnecessary, for on the contrary, such is the only means by which the annual losses can be determined with accuracy and the progress of control measured.

During the year a considerable amount of more or less purely ecological work has been done; this has involved a great deal of study of the available literature on the geology and botany of the island as compared with the whole West Indian area, as well as a vast amount of actual field work on the flora. Following the lead set by Dr. Myers, a detailed study of the plants, and more particularly, the plant-associations, has been commenced, which is to be correlated eventually with a study of the soil and climatic conditions, wild plants being excellent indicators of both. The work

has been greatly facilitated by the valued co-operation of Mr. A. E. Collens, Government Chemist, and Mr. C. F. Charter, of the Antigua Grammar School; Mr. W. R. Forrest has also aided the writer with his store of knowledge on the geology of the island. It would be premature to record the details of the considerable amount of work that has already been done in this direction, but it may be mentioned that notes have been made on the composition of the main types of vegetational zones throughout the area; a spare-time project being undertaken by Mr. Charter in collaboration with the writer is a complete ecological survey of Sugar-loaf Mountain (Falmouth Peak), including the recording of meteorological data. The results of this investigation will naturally be considered apart from that for which the Colonial Development Fund grant was made, though the two separate projects are mutually related.

Since Dr. Myers' visit in August last, special attention has been given to a study of the Grasses (*Gramineæ*), not only because of their value as ecological indicators, but also because they include the only alternative hosts of *Diatræa saccharalis* known with any degree of certainty—I agree with Dr. Myers that the records of *Diatræa* occurring in sedges (*Cyperaceæ*) are doubtful. A collection of the grasses of Antigua has been made which can be regarded as practically complete. A first consignment of 114 mounts was sent in November to Dr. A. S. Hitchcock, Systematic Agrostologist to the U.S. Department of Agriculture, Washington, D.C., who reported that seventy-six distinct species were represented. Of these, twenty-one species were hitherto unrecorded from Antigua, one of them being new to the West Indian flora and another, to be known technically as *Eriochloa boxiana*, new to science. An additional series of mounts has been made which, together with the forms which it is hoped to encounter in St. Kitts and Nevis early in 1932, will be sent to Dr. Hitchcock for determination. Full ecological notes have been made on every species, and later it is hoped to publish a detailed account of the grass-flora of Antigua with comparative notes on the other islands.

Besides sugar-cane, corn and guinea-corn, *D. saccharalis*

has been found in the following grasses in Antigua: *Tripsacum laxum, Coix lachryma-jobi, Pennisetum purpureum, Trichachne (Valota) insularis, Panicum barbinode, Arundo donax, Paspalum virgatum* and *Echinochloa polystachya (spectabilis)*. The degree of infestation among these wild hosts varies considerably, several of them being no more than casually attacked from neighbouring canes; the case with the giant succulent grass *E. polystachya* is different, however, and in this there is reason to believe we have the original primitive host of *D. saccharalis* in Antigua. As with the other instances recorded by Dr. Myers, it is rather a question of the association in which the host occurs than the species of host itself which determines whether a grass is attacked by *Diatræa*.

An important development during the year is the guaranteeing of the sum of £200 by the planters and factory-owners for the purpose of importing into Antigua the Cuban parasite of the larva—*Lixophaga diatræa*, Towns. This introduction figures among the most promising lines of control, but unfortunately no money was available either on the Colonial Development Fund grant made to the Government of Antigua or the Empire Marketing Board grant which covers Dr. Myers' activities in the West Indies; rather than not have this experiment carried out, therefore, the sugar-producers decided to finance the work themselves, which is a magnificent tribute to the good work done by Dr. Myers since his arrival in this part of the world. It is planned to make the introductions in 1932.

During the year numerous minor reports have been made. Two local publications have been issued: (i) "The Deterioration of Planted Cane-cuttings," issued as a Supplement to the *Leeward Islands Official Gazette* in June, and (ii) *Observations on Sugar-cane Cultivation in Antigua, with Suggestions for Improvement* (28 pp., Government Printing Office, St. John's), written in collaboration with Messrs. A. E. Collens and F. H. S. Warneford.

The writer has had little opportunity to continue systematic work on *Diatræa*, though the collections of Dr. Myers and those of Professor H. A. Ballou and Mr. F. W. Urich have been named and returned to the senders.

Mr. H. B. B. Moore has sent the writer an interesting species reared from the sea-shore grass *Spartina brasiliensis* in British Guiana, which does not agree with any of the forty-eight species dealt with by the writer in his recent revision of the group and which is probably new to science; more specimens are necessary before the identification can be made with certainty. A species of *Spartina* occurs in Antigua, but no borers have been discovered in it.

Three collections of material from the Orient have been received, but the writer will have to postpone their determination until his return to England, because of lack of access to literature and type material; they include bred series of *Diatræa* from Formosa, the Malay States and the Philippine Islands.

The writer's collection of larvæ has been augmented through exchanges effected with the United States National Museum, one species, *D. magnifactella*, being added (exch. with larvæ of *D. bellifactella*).

NOTES

The Oil Palm in Malaya.—The following information which was compiled recently for a correspondent of the Imperial Institute may be of general interest to readers.

The palm oil industry in Malaya has shown steady progress since planting on a commercial scale was started in 1917. The areas of oil palm plantations in both the Federated and Unfederated States, as shown in the Reports of the Department of Agriculture for the last five years available, are as follows:

Year.	Acres.
1926	12,548
1927	19,755
1928	24,730
1929	31,709
1930	45,247

Of the total area in 1930, 19,475 acres are recorded as mature, and 16,391 acres as immature. The position of the remaining areas, mostly in the State of Johore, was not determined.

Areas considerably in excess of those already planted have been alienated by the Government for oil palm planting, and there is every prospect that the industry will continue to expand.

Many of the estates have well-equipped factories for the production of palm oil and the separation of the kernels, and the number is increasing year by year, six new factories being opened in 1930. In general the centrifugal type of extractor is favoured in Malaya, in contrast to Sumatra, where the press system is preferred. Opinion is still divided as to which system gives the better results and machinery has recently been installed at the Government Experimental Factory at Serdang with a view to comparing the two systems.

Palm oil and palm kernels have been shipped from Malaya since 1923, but exports were not shown in the official trade returns till 1927. Net exports from that year onwards have been as follows:

Year.	Palm oil. *tons.*	Palm kernels. *tons.*
1927	786	175
1928	1,334	255
1929	1,831	263
1930	3,211	485

Shipments are principally to the United States.

Malayan palm oil, like that from Sumatra, is of excellent quality and fit for edible purposes, the free fatty acid content being generally between 3 and 5 per cent. as compared with figures ranging from 8 to 80 per cent. in the case of West African palm oil which, in general, is only suitable for soap-making and similar purposes. The market value in the United Kingdom of the Malayan oil varies from about *7s. 6d.* to *27s. 6d.* per ton above that ruling at any particular time for the West African product.

An important stage in the Malayan palm oil industry was reached on October 18, 1931, when the first bulk shipment of the oil, amounting to about 102 tons, was made from Kuala Selangor to Belawan on the East Coast of Sumatra. At this latter place there is a large tank installation, enabling the oil to be mixed with oil produced in Sumatra before shipment by ocean-going steamer. The reason for this procedure is that shipments of not less than about 800 tons are preferred by buyers, who are willing to pay better prices than for smaller consignments. It is hoped, by erecting a large storage installation at one of the Malayan ports, that in a few years' time it will be possible to load the oil direct into ocean-going steamers.

The Malayan Government are fully alive to the importance of the industry and extensive research on the cultivation of the oil palm is being carried out by the Department of Agriculture. Matters that are receiving particular attention are seed selection, the much-debated

question whether artificial pollination is desirable, pruning the palm, manuring, pests and diseases and, as already mentioned, investigations on the manufacturing side. Reference to this work will be found in the half-yearly reports of the Department, published from time to time in this BULLETIN, under the heading "Recent Research on Empire Products."

Indian Pulp and Paper Industries.—In 1925 the Indian Tariff Board, as a result of representations made by Indian paper-makers, considered the question of granting protection to the industry with the objects of freeing it from dependence on foreign materials and of eventually developing an export trade in bamboo pulp. Reference to the report and recommendations of the Board was made in this BULLETIN (1925, **23**, 466).

The protective duties imposed on certain kinds of paper under the Bamboo Paper Industry (Protection) Act, 1925, expired on March 31, 1932, and the Tariff Board was requested by the Government of India to ascertain the extent to which the Act had achieved its purpose and to consider whether the continuance of protective measures was desirable. Enquiries were made accordingly and the results have been published in the *Report of the Indian Tariff Board on the Grant of Protection to the Paper and Paper Pulp Industries* (Calcutta, 1931). Some of the principal findings and recommendations of the Board are mentioned in the following paragraphs.

The total consumption of paper (including pasteboard) in India increased from 111,963 tons in 1924–25 to 175,627 tons in 1929–30, but fell to 154,277 tons in 1930–31, and of these quantities the Indian mills have steadily supplied from 22 to 25 per cent. The consumption of paper of protected classes increased from 43,331 tons in 1924–25 to 53,584 tons in 1929–30 but fell to 49,046 tons in 1930–31, and of this paper the Indian mills supplied from 53 to 71 per cent. There are now nine paper-mills working in India, the total output of which in 1930–31 amounted to nearly 40,000 tons.

There has been a large increase in the use of imported wood pulp by the Indian mills and this is attributed partly to the fact that the financial aid proposed by the Tariff Board for the development of bamboo was not granted and partly to the fall in the price of wood pulp. It has led to an annual expenditure of about Rs. 20 lakhs on Indian materials and labour which would otherwise have been spent on imported paper. The additional market for paper in India which the Indian mills may expect to

capture is about 20,000 tons per annum, apart from any normal increase in consumption.

Bamboo is available in India and Burma in sufficient quantities not only to supply the entire Indian demand for pulp, but also to develop a large export trade. Air-dry bamboo which cost about Rs. 55 per ton in 1924–25 is now obtainable at Rs. 38–40 or even less. Considerable progress has been made regarding the mechanical treatment of the bamboos and further experiments are being undertaken. The digestion of the material is effected by the acid sulphite process at the India Paper Pulp Company's mill at Naihati and by the alkali process (usually with fractional digestion) at the other mills. The bamboo paper has proved to be of satisfactory quality for most purposes. The future of the Indian paper industry depends on the exploitation and development of bamboo and it is anticipated that paper made from it will eventually be able to dispense with protection; grass also occupies a recognised place in the industry, and should be subject to the same proposals for assistance. The withdrawal of the protective duty at the present time would lead to the disappearance of bamboo as a paper-making material and this would be a national loss; it would cripple the resources of the Indian mills and endanger their existence. Direct encouragement for the development of bamboo could most suitably be afforded by the imposition of a duty on imported pulp, which should be fixed at Rs. 45 per ton. The duty on paper should be continued at the present rate of Rs. 140 per ton or one anna per lb. These duties should remain in force for a period of seven years. The duty on paper should be applied to printing and writing papers which are now liable to the protective duty, and no alteration should be made in the existing tariff entries regarding newsprint and packing paper.

Although some progress has been made towards the Indianisation of staff and with apprenticeship schemes, the principal mills have not made sufficient effort to attract and offer employment to Indians, especially in the paper-making section of their works, and this matter should receive early attention.

Steps should be taken to develop the Paper Pulp Section of the Forest Research Institute at Dehra Dun, with the object of co-ordinating the experimental work carried out by the mills.

Agricultural Journal, Barbados.—The Department of Science and Agriculture, Barbados, are in future issuing their Report in four quarterly instalments, under the title *Agri-*

cultural Journal. It is intended that the April issue shall be a brief summary of the year's work ; those published in July and October will present the results of experimentation, while the January number will be devoted as far as possible to original scientific papers. The first number, bearing the date January 1932, has just been received. Most of the papers relate to the sugar industry and include : " An Investigation into the Evolution of Sugar Cane Varieties by Breeding in Barbados, 1887–1925, with a Discussion on the Application of the Findings to the present-day Scheme of Work," by A. E. S. McIntosh ; " A Survey of the Position of *Phytalus smithii*, Arrow, and its Natural Enemies in Barbados," and " The Status of *Trichogramma* as a Control of *D. saccharalis* in Barbados," by R. W. E. Tucker ; " The Scientific Control of Pan Boiling," by S. J. Saint ; and " The Inversion of Sucrose in Syrup Manufacture," by C. A. Coppin. There is also the first instalment of a treatise by F. Hardy, entitled " Some Aspects of the Flora of Barbados," and the number concludes with a short memorandum on the cotton situation in the island.

The Veterinary Bulletin.—The Imperial Bureau of Animal Health are issuing under this title a monthly journal devoted to abstracts of papers and reports and reviews of books relating to veterinary research, administration, public health and education. The abstracts are classified according to their subjects and a full contents list and author index is published in each number. An author index and subject index will be issued for the annual volume, which runs to about 864 pages. The subscription is £2 for the volume, or 5*s.* per number, payable in advance, post free to any part of the world. Subscriptions should be sent to The Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture and Fisheries, Weybridge, Surrey.

Diseases of Sheep.—The April, 1932, issue of *The Veterinary Journal* (vol. 88, No. 4) is a special number devoted to papers on research work carried out in this country and other parts of the Empire on various aspects of sheep diseases. In an editorial note attention is drawn to the fact that the research work already carried out in recent years has resulted in a saving to the country and to agriculturists of hundreds of thousands of pounds. Now that a properly organised scheme of research is possible under the newly formed Veterinary Research Council, progress should be even more rapid.

The subjects discussed in the articles include the diffi-

culties in connection with the eradication of sheep-scab in Great Britain; swingback (ataxia) in lambs; the sheep maggot fly; internal parasites of sheep; a new Trichomonas found in the gut of a sheep; ailments of sheep in New Zealand; sheep diseases in Egypt; and "sheep-sick" land. The *Journal* is published by Baillière, Tindall & Cox, price 2*s*.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Insect Pests

Locusts

Nigeria.—The Senior Entomologist, Department of Agriculture, in his report for the six months ending December 31, 1931, states that further experiments with poisoned baits against locust hoppers were carried out in July at N'Guru in the north-western corner of the Bornu Province. A bait consisting of chopped hay and sodium fluosilicate (30 lb. carrier to 16 oz. poison) was applied at the rate of 75 lb. per acre to a band of second instar hoppers; about 86 per cent. of the band died within 48 hours of the application. Only three other bands were available and all were in the fifth instar and somewhat lethargic on account of the imminence of the final ecdysis. A bait composed of torn-up newspaper and sodium arsenite was applied to two of these bands and, as a control, hay-fluosilicate bait was scattered over the third; within 72 hours, 15 and 1 per cent. respectively of the first two bands had died and 1 per cent. of the control. The experimental conditions were very unfavourable as the hoppers were not feeding readily.

In September, further investigations were carried out at Mongonu, near Lake Chad. As guinea-corn bran is the principal carrier in that area, it was decided to utilise this substance exclusively as a base in further tests of fluosilicate baits; in May, baits composed of this bran and fluosilicate had given most unsatisfactory results, while later in the year baits consisting of fluosilicate and saw-dust or chopped hay had proved to be very efficient. About 1,845 lb. of bran were mixed with sodium fluosilicate at the rate of 30 lb. carrier to 12 oz. of poison, and the resulting

bait, after being moistened, was applied to five bands of second and third instar hoppers with a total area of 14 acres. After 48 hours, only 20 per cent. of the first band and 15 per cent. of the second had died, while none of the hoppers in the remaining three bands was killed. It was then decided to incorporate common salt in the bait and 1,542 lb. of bait, consisting of guinea-corn bran, sodium fluosilicate and salt in the proportions, 30 lb., 12 oz., 12 oz., were prepared. This bait was applied to three bands of third instar hoppers with a total area of 13½ acres, and, in two instances, gave more satisfactory results than the standard arsenical bait ; while, in the third, although few hoppers were killed, the band dispersed after being baited. It is evident that it is essential to add salt to baits containing fluosilicate as the poison and guinea-corn bran as the carrier. In Nigeria, baits containing both salt and fluosilicate are cheaper than the standard arsenical bait at points near the railway ; but, owing to the increased cost of transport, are more expensive in remote regions such as the Chad area of Bornu. From a study of work carried out elsewhere it appears that sodium fluosilicate is somewhat less toxic than arsenicals to stock and, even more important, baits containing this poison are repellent to stock while those containing sodium arsenite are attractive. Arrangements are being made for a large-scale test of fluosilicate baits in the near future.

The shores of Lake Chad are regarded as a possible permanent breeding ground of the Migratory Locust, so a survey was made of this area in October and November. The shore was visited at nine different points and a collection was made of orthoptera, grasses and soil samples ; the insects and plants are being determined by the appropriate authorities and the soils are being analysed by the Chemical Section of the Nigerian Agricultural Department. Solitary individuals of *L. m. migratorioides* were only common at Bisagana in the extreme north of British Chad, but there seems little doubt that the Chad area is a permanent breeding ground of the Red Locust, *Nomadacris septemfasciata*, Serv. ; further research is required to ascertain the rôle of this area in the case of the Migratory Locust.

Beverages

Cocoa

Gold Coast.—The following report on investigations conducted by the Department of Agriculture, during the period July 1931–December 1931, has been furnished by the Director of Agriculture.

The work carried out, additional to that described in the previous report, included further cocoa research, and large-scale promotion and initial guidance of cocoa producers' co-operative societies. Reports on these activities are to be found in Papers I–VIII, and X–XIII, *Year Book* 1930.

With the object of studying the economic aspects of pod diseases on cocoa grown under conditions of ordinary native practice, local farms in the Anyinam District have been the subject of detailed observations since 1926. Much useful information has been obtained. The dissimilarity in annual fluctuations in periodicity, production and pod disease found to occur between different farms in the same district has led Mr. Dade to the conclusion (Paper XIII, *Year Book* 1930) that local environmental conditions are equally as important as meteorological conditions in determining those factors. A relation was traced between the incidence of disease and the morphology of the tree and pod. In the years in which the proportion of diseased pods was high, a smaller proportion of pods received infection near the stalk and a larger proportion towards the middle ; the proportion infected at the tip did not vary appreciably from year to year. Previous observations on Cushion Canker were confirmed statistically. Canker was the cause of 9–14 per cent. of the total infections. Cushions infected with the disease transmit it to the pods borne on the cushion in the following year, with the result that the cushions are destroyed, and cease bearing ; of 201 such cushions observed, 197 produced no crop in the third year. Cast Offs, the term given to the large numbers of pods which die before reaching maturity, were also studied. The cause of the phenomenon was found to be the simple inability of the tree to provide all the pods produced with sufficient food ; in observed tests in 1930, the number of shed pods was so large that, if they had all been able to mature, the yield of the crop would have been at the rate of 2,600–5,500 lb. of dry cocoa per acre.

The observations on these native farms will be continued.

An adequate summary of the activity of the Department with regard to Co-operative Societies is beyond the scope of this report. Two aspects of the work, however, may be found illuminating.

Year.	No of Societies	No of Members.	Share Capital Subscribed.	Quantity of Cocoa produced.
1930 . .	31	724	£908	354·5 tons
1931 . .	247	4,473	£2,493	1,489 ,,

II

—	Mean Percentages of Defects.					Commercial Purity.
	Mould.	Slate.	Weevil.	Germinated	Otherwise Defective.	
Co-operative Societies.	0·9	0·9	0·5	0·8	0·4	96·8
Total Crop.	3·6	4·6	1·0	2·2	0·8	87·8

The increase in the number of societies during the year was striking, while the cocoa sold by co-operative societies was greatly superior in every particular, showing that it was more carefully harvested, fermented, cured, dried and stored than the average cocoa prepared by other farmers.

Errors in sampling cocoa forms the subject of Paper X, *Year Book* 1930, by Mr. Waters. The mathematical subject-matter does not lend itself to condensing, but attention must be directed to it in this report. The importance of the work need not be stressed.

Nigeria.—The Botanist, Southern Nigeria, reports that it was found possible to commence a programme of selection and breeding work with cocoa early in 1931. Advantage has been taken of individual tree records, kept over the last ten years, of 450 yellow Forastero amelonado types growing at Moor Plantation, Ibadan. As a preliminary, 49 trees were selected, mainly on the basis of producing an average of over 70 pods per annum over the seasons 1921–31 or producing an average of over 90 pods per annum over the seasons 1926–31. A more detailed method of recording was introduced in March 1931 for these trees, and at each harvest (once every three weeks) the weights of pods and wet beans are recorded. A reduction by at least half of the original selections is expected when the present season is finished, some of the heaviest-yielding trees having beans of an inferior quality, and others being susceptible to diseases.

Eight acres of land were cleared, and banana and *Erythrina umbrosa* planted during the rains. This will form a block of land ready for an extensive trial of the progenies of the final selections.

In order to obtain information and technical experience in self-fertilising cocoa flowers, experiments were started during the past year and are being continued to complete the annual cycle ; the final results are not yet available. A note on the method employed is being published in the 1931 Bulletin of the Department.

According to the report of the Mycological Branch for the period July–December 1931, cocoa fermentation experiments have been continued on native farms using

the methods actually employed by the farmers. Fermentations were carried out using both average samples of cocoa such as a farmer normally harvests and also samples of beans which were from fully ripe pods. These were fermented in heaps on banana leaves and covered by these, and also in pits lined by banana leaves. Some samples were changed daily and others were changed twice and three times throughout the process. The samples from heaps showed a greatly superior fermentation to those from pits. And again there was little evidence to justify changing the beans every day throughout the process, as a product of good quality was obtained by changing only once and twice. These experiments were repeated later in the season when samples changed daily in pits and heaps were compared with samples changed after 48 hours and 96 hours only, also in pits and heaps. As before, those in heaps fermented much better and the sample changed only twice throughout the process was of quite as good a quality as that changed daily for six days.

All the conditions of this latter series of fermentations were strictly comparable, for the time of fermentation was the same in each case, viz. 6 days, and the weight in each case was also the same, viz. 82 lb. wet beans. It was considered that small lots such as these would be such as the average native farmer on a small farm would deal with.

Sufficient evidence has now been collected under actual farm conditions to justify advocating two changes, viz. after 48 and 96 hours during a six days' fermentation, and such treatment will give a product which would be of Grade I quality under the Nigerian Produce Regulations.

The conditions of the experiments on the control of Black Pod disease were outlined in the previous report. Since then spraying and dusting have been carried out three times in all. The spraying with Bordeaux mixture appears to give the best results. It adheres much better than the dusts. Of the two dusts used sulphur (olite) appears to adhere better than copper carbonate. All the treated plots have shown a higher yield of pods than the untreated plots; the table below gives the total yields to date:

No. of Plot.	Treatment.	Treated.		Untreated.	
		Good Pods.	Black Pods.	Good Pods.	Black Pods.
1	Sprayed Bordeaux mixture .	1,701	96	1,224	353
2	Dusted copper sulphate .	1,574	261	1,417	540
3	Sulphur dusting . . .	6,011	855	4,611	1,036
4	Only thorough sanitary measures carried out . .	5,918	637	6,895	656
5	Pruned trees on treated plot. No special measures . .	532	123	370	124

In plot IV, where good sanitary measures only were undertaken, i.e. complete removal of all black pods and burial of pod husks, the yield on the treated plot is actually less than on the untreated. However, there is every indication that the later harvestings will be much heavier on the treated half.

The percentage of black pods in treated and untreated plots is given below. These figures only refer to the crop returns at present available. The experiment is being continued.

Plot.	Treated.	Untreated.
1	5·6	28·8
2	16·5	38·1
3	14·2	22·4
4	10·7	9·5
5	23·1	33·5

CEREALS

Guinea Corn

Nigeria.—The Botanist, Northern Provinces, reports that two strains, FA and FB, selections from "farafara," the most popular guinea corn in this area, which gave increased yields of 29 and 33 per cent. over local guinea corn, have been re-tested this season. The following results ensued :

Trial 1. *Samaru Plantation*

Average yield per acre, 31⅛ acre plots of local farafara	433 lb. grain.
Average difference per acre, 10⅛ acre plots of FA	+ 21 ± 22 ,,
,, ,, ,, 10⅛ ,, ,, FB	+ 132 ± 22 ,,

Trial 2. *Maigana Plantation*

Average yield per acre acre, 20¼ plots of local farafara	268 lb. grain.
Average difference per acre, 5¼ acre plots of FA	+ 23 ± 16 ,,
,, ,, ,, 4¼ ,, ,, FB	+ 34 ± 17 ,,

Trial 3. *Botanical Small-scale Yield Trial*

Average yield per acre local farafara	740 lb. grain.
Average difference per acre FA	+ 231 ± 70 ,,
,, ,, ,, FB	+ 229 ± 70 ,,

Seven tons of grain of strain FB will now be given out to farmers within a radius of twenty or thirty miles of Zaria.

LEGUMES

Beans

Nigeria.—The Botanist, Southern Provinces, in his report for the six months July to December 1931, states that recent work on beans has been concerned mainly with local white-seeded Limas and Popondos (varieties of *P. lunatus*). A selection of Popondo has now reached the stage of being tested on a field scale against Mucuna

(*Mucuna aterrima*), the standard green manure at Ibadan, regarding its capabilities of providing an adequate cover and of maintaining fertility under permanent cultivation. Attempts to rid this selection of a yellow discoloration of the testa, which increases on storage, have so far proved unsuccessful. Otherwise, the edible qualities of this selection appear to be good. Selection work has been concerned with the testing out of the progeny of natural and artificial crosses between Limas and Popondos. A few individual plants, having superior qualities, are to be multiplied next season for extended trials.

A paper is appearing in the 1931 *Annual Bulletin* describing the present position of the work with beans. In brief, two lines of investigation have been followed. The introduction of exotic types, of economic importance elsewhere, has not been successful. The non-edible types in general cannot compete with Mucuna as green manures. Of the edible types, the majority of which were varieties of *P. vulgaris*, and mainly indigenous to sub-tropical regions, very few seemed able to adapt themselves to the new environment. On the other hand, from collections of local beans, several promising types have been isolated. Of these, white-seeded Limas and Popondos are now occupying attention. From this material it is hoped to obtain the desired type of bean.

Fruit

General

Gold Coast.—According to the report of the Agricultural Department for the period July–December 1931, the possibility of a fruit export industry for the Gold Coast was further examined during the year. Hitherto the high profits for little labour obtained from cocoa has rendered any other industry uninteresting to Gold Coast farmers. The fall in cocoa prices has altered this attitude somewhat. There are no agricultural difficulties in the way of a fruit industry. Bananas, including Canary and Gros Michel, already exist and grow well throughout the Colony. This also applies to oranges, grape fruit and pineapples. The grape fruit alone does not compare favourably with its counterpart in other countries. Native types of oranges, however, are of good quality and a variety of pineapple, the Smooth Cayenne, particularly suitable for canning, occurs and thrives in various parts of the Colony. The most suitable lines for investigation were therefore considered to be banana plantations, orange packing and pineapple canning. Preliminary trials in the two latter activities

were begun at Kpeve and Asuansi Stations. Bananas do not lend themselves to this method of investigation, but the difficulties in the way of an export industry in this crop were studied, both on the Gold Coast and in England. These may be stated here. A large-scale export industry in bananas implies orderly production and shipping. Banana ships could not operate unless assured of regular supplies. As local peasants could not be depended on in this respect, European-owned plantations would need to be established as the basis of the industry. The industry could then expand by supplementary supplies grown by the native farmers. The establishment of plantations presents further difficulties: provision of capital, supply of labour, inland transport and land tenure. Thus, although there are no agricultural difficulties in the creation of an export in bananas, there are many points which require investigation, preferably by an experienced commercial man who knows the trade. Investigations on these lines are being continued.

Citrus

Leeward Islands.—*Dominica.*—Mr. F. G. Harcourt, Curator and Agricultural Superintendent, in his half-yearly report ending December 31, 1931, points out that the principal problems confronting the Agricultural Department are those concerned with the causes relative to the virtual destruction of the lime industry of the island. These are: (1) the advent of withertip disease in 1922; (2) the epidemic of root disease, which commenced in 1926 and is still prevalent; and (3) the severe storms or hurricanes of 1926, 1928 and 1930.

1. *Withertip Disease of Limes* (*Glœosporium limetticolum*).—The effect of this disease was such that within four years of its discovery exports of lime products fell over 50 per cent. The disease was so virulent in the wetter districts of Dominica that many large plantations had to be abandoned and the growing of the lime confined to the drier lands on the coast. Efforts to control the disease by spraying proved of no avail owing to the frequency of heavy rains for which Dominica is noted. The only hope therefore of continuing the industry in wet districts was to discover a lime immune to the disease. Many species and varieties of sour citrus were introduced from various parts of the world, but although the properties of the fruits of several of these introductions closely approximated to the lime, and the trees proved immune or highly resistant to withertip, not one could be considered in every way a suitable substitute for the West Indian lime. The

Woglum lime proved to be one of the nearest in quality of juice, acid content and oil, but the fruits were large and unsuitable for the green lime trade. Having proved that the Woglum lime was highly resistant to withertip, and the properties of the fruit very similar to the West Indian lime, it was decided to cross this lime with the West Indian lime, using the Woglum as female parent. This work was commenced in 1926, but the hurricane of that year destroyed all the successful crosses. The work was continued the following year, 44 crosses were successfully made and 344 hybrid seedlings raised. These were planted in a withertip area and grafted on Sour Orange stock to preserve them from attacks of root disease, as a few were lost through this disease attacking the seedlings. Despite the fact that these plants have been badly battered by two hurricanes they took well and have commenced to fruit. Immunity to withertip has been maintained in most of the hybrids, which show considerable variation in foliage characteristics, ranging from the small leaf and spines of the West Indian parent, to the large leaf and spineless Woglum. Tests of a comparative nature with the fruit of the West Indian lime have not yet been made. Several of the most promising hybrids have been back-crossed with the West Indian and seedlings raised. These will be ready for planting out in the field during the next planting season. Similar crosses have also been made between *Citrus aurantifolia* and the West Indian lime ; 150 trees of this particular cross are growing in our trial grounds and are commencing to fruit. More time and attention is called for this particular work than the present staff of the Department is able to give and it is only with difficulty that the work has been carried to its present stage.

2 and 3. *Red Root Disease* (*Sphærostilbe repens*) *and Hurricanes.*—These two problems may be considered together, as the safeguarding measures to be adopted by planters are incidentally the same. In a report dated February 21, 1931, Mr. Harcourt definitely stated that budding the lime on Sour Orange stock is the solution to the problems and gave the reasons prompting his decision. It therefore will be sufficient for this report to indicate the progress made in raising this particular type of plant for distribution to planters. Large citrus nurseries are established at the Department's headquarters and five subsidiary nurseries are established in country districts. The total number of budded limes propagated and distributed from January 1, 1927, to December 31, 1931, is 57,852. Stocks growing in the nurseries are estimated to provide 50,000 plants for 1932, and sufficient Sour Orange

seed has been sown to provide 75,000 stocks for budding in 1933. Citrus nursery work on a large scale entails considerable work and supervision, and difficulties continually occur. The Department's present concern is the heavy infestation of citrus scab and the "damping off" of young seedlings in the seed beds. Very wet weather has made it extremely difficult to keep these diseases under control despite the continued use of sprays. The following table will show the number of budded lime plants distributed by the Department during the year 1931 and previously:

1927	—
1928	1,117
1929	6,182
1930	24,100
1931	26,453

Oil Seeds

Coconuts

Gold Coast.—The following report on investigations conducted by the Department of Agriculture during the period July 1931 to December 1931 has been furnished by the Director of Agriculture.

Progress made on the plantation at Atwabo since its inception has been described in previous reports. Paper XVIII, *Year Book* 1930, by Mr. Fishlock, deals with the extension work which has been done from this station. Propaganda in the district has been carried on since the opening of the station. At first the effect was small, until the people saw the palms bearing, and copra being made and sold; a recent survey of the area revealed that of 111 farms planted only 14 were more than three years old. The farmers obviously waited to see what success attended the Government Plantation before moving themselves. If a large industry should develop in the district, the credit may fairly be claimed by the Department. Mr. Fishlock has estimated that 35,000 acres are suitable for coconuts in the area; 15,000 near the beach and 20,000 further inland. The light sandy soil, heavy rainfall, maritime conditions and the presence of water percolating underground to the sea, make this area ideal for the cultivation of the crop. Because of its situation, heavy overland transport charges would not have to be met. The industry, it is stated, would be well suited to a people not accustomed to prolonged steady work.

During 1929 and 1930, a survey of the coconut industry in the Keta-Ada District was carried out by Mr. Martinson (Paper XIX, *Year Book* 1930). The area is situated on the coast on the south-east side of the Colony. It is character-

ised by a low rainfall averaging 34·14 inches with a mean of 45 wet days in the year. The industry is maintained on both sides of a salt-water lagoon peculiar to the district. The soil is variable, being sandy on the littoral and relatively heavier on the mainland. The standard of farming practice also varies with the situation of the farms; many coconut farms along the coast are neglected, while on the mainland manuring and cultivation are practised. Harvesting occurs four times a year. The standard of preparation of copra is poor; the copra is imperfectly dried, left uncovered at night, and afterwards badly stored. The incidence of disease and insect attack is not heavy. Ninety-eight per cent. or 1,311 tons of the total copra exports for the Colony are produced by this district. This represents 42 per cent. of the total production in the area as estimated by the survey; the remainder is consumed locally. The survey revealed that the area suitable for expansion in the district was small.

Ground-nuts

Nigeria.—The Agricultural Botanist, Northern Provinces, has furnished the following results of the 1931 yield trials, in continuation of his report in this BULLETIN (1931, **29**, 335).

(*a*) Zaria Spreading Ground-nuts

1931 Yield Trial:		Yield as per cent. of control.
Average yield of 13 plots of local ground-nuts. kernels p.a.	349 lb	100 per cent.
Average difference of 4 plots of Eb $+ 22·75 \pm 18·3$		106·5 ,,
,, ,, 4 plots of Lr $- 15·25 \pm 18·3$		95·6 ,,
,, ,, 4 plots of Ko $+ 46·5 \pm 18·3$		113·3 ,,

In 1930 the percentage increases of strains Eb, Lr and Ko were 22·4 per cent., 13·9 per cent. and 16·7 per cent. respectively. Strain Ko has given a steady increase of over 10 per cent. during four years of trial and will now be multiplied for distribution to the native farmers.

(*b*) Zaria Upright Ground-nuts

1931 Yield Trial:		Yield as per cent. of control.
Average yield of 13 plots of local ground-nuts. kernels p.a.	701 lb.	100 per cent.
Average difference of 4 plots of Bi $+ 195 \pm 48$	.	127·8 ,,
,, ,, 4 plots of Bu $+ 120 \pm 48$	.	117·1 ,,
,, ,, 4 plots of Cc $+ 188 \pm 48$	.	126·8 ,,

In 1930 the percentage increases of strains Bi, Bu and Cc were 11·5 per cent., 18·8 per cent. and 15·0 per cent. respectively. It is intended that all three types be re-tested on a large scale in 1932, whilst seed of Bi and Cc will be multiplied in the hope that one of these may prove worthy of distribution in 1933.

(c) Kano Spreading Ground-nuts

1931 Yield Trial:

		Yield as per cent. of control.
Average yield of 26 plots local nuts.	1,308 lb. kernels p.a.	100 per cent.
Average difference of	5 plots Philippine White $- 123 \pm 62$	90·6 ,,
,, ,,	5 plots Strain Sc $+ 90 \pm 62$ . .	106·9 ,,
,, ,,	5 plots Strain Pr $+ 47 \pm 62$ . .	104·4 ,,
,, ,,	5 plots Strain Lr $+ 18 \pm 62$ . .	101·4 ,,
,, ,,	5 plots Strain Eb $- 90 \pm 62$ . .	93·1 ,,

In the 1930 trials Philippine White gave an increase of 19 per cent., whilst strains Sc, Pr, Lr and Eb gave increases of 24·2 per cent., 21·0 per cent., 19·8 per cent., 19·2 per cent.

The 1931 season was unusually wet and the disappointing results may be due to the fact that the local nut stood up better to the prevailing conditions, and all the above types will probably be re-tested next season.

Uganda.—The following results of experiments with ground-nuts are recorded in the report of the Serere Experiment Station for the period July 1–December 31, 1931.

Apart from very frequent locust attacks the past season was exceptionally favourable for the ground-nut crop here, and with one exception all plots did well.

One small bulk increase plot of "bunch" type, mass selected for the first time in 1929, gave an estimated yield of 2,513 lb. of unshelled fruits per acre. A block of the same type, 4·82 acres, gave at the rate of 1,497 lb. per acre. The "spreading" type averaged out much lower all round. As a comparison 4 acres gave at the rate of 870 lb. only.

A good deal of "rosette" disease appeared during the season, but mostly in the later stages of growth and so did not affect the yield so adversely as if it had appeared earlier.

In the spacing and cultural trials in which the "Bunch" type was used, harvesting took place about the middle of August. The 1 ft. by 1 ft. spacing gave definitely better results than the other spacings used, while there was no significance between the methods of cultivation adopted.

Spacing and variety trials were carried out with both the "bunch" and the "spreading" types. In the case of the former very little difference in yields was obtained, as seen by the following figures, totals from five repetitions. If anything there is a little in favour of the newly introduced Virginia Bunch from Tanganyika.

Virginia Bunch, 322 lb.
Serere Bunch (ordinary seed), 314½ lb.
Mass selected Serere Bunch, 312 lb.

The results with the "spreading" type, the total of the five repetitions under each treatment, were as follows:

Ordinary seed.	Spacing $1\frac{1}{2}$ ft. × $1\frac{1}{2}$ ft.	. .	158 lb.
,, ,,	,, 2 ft. × 1 ft.	. .	162 ,,
Selected seed.	,, 2 ft. × 1 ft.	. .	$181\frac{1}{2}$,,

An investigation was made into the cost of different methods of harvesting. The conclusions formed from data, collected over 4 acres of each of the "bunch" and "spreading" types, are, that it is more economical to harvest the crop in native fashion (bent-handled hoes) in preference to either ploughing out with the ordinary E.C. plough in common use, or the digging out with Lumbugu forks, and that a much larger yield can be obtained from the "bunch" type, which is also more easily handled.

Oil Palm

Gold Coast.—According to the report of the Department of Agriculture for the half-year ending December 31, 1931, the Bukunor Palm Oil Mill, the first mill built and operated under the Government Subsidy Scheme (vide Report for July–December 1929), was completed during the year. It is situated in the Volta River District of the Eastern Province and is owned by the Palm Oil Estates Managers Ltd. The Bukunor mill has a nominal rated capacity of 3,000 tons of palm fruit per annum, which is equivalent to an annual output of about 500 tons of palm oil and 350 tons of palm kernels. Commercial milling began on January 20, 1931. The price paid for the fruit was £2 9*s*. per ton. From January 20 to end of March, 1931, the amount of fruit milled by the factory was 353 tons, of which 197 tons were supplied by farmers during March. In the beginning both the quantity and quality of the fruit brought in were unsatisfactory; but this was being remedied when the mill had to close down temporarily at the beginning of June 1931. This latter measure was rendered necessary by the fall in the price of palm products. In March 1929, when the mill agreed to pay producers at the rate of £2 9*s*. for a ton of fruits, the Liverpool market price of palm oil was £37 8*s*. a ton, and of palm kernels, £18 19*s*. per ton; whereas in March 1931, these prices had dropped to £19 8*s*. and £11 10*s*. respectively. Values depreciated still further in April and May. In consequence the mill was unable to make a profit and had to close down as a temporary measure, until prices should improve. It is disappointing that the success of this large-scale enterprise should be jeopardised by a

period of low prices—a contingency over which there was no control.

Nigeria.—The Botanist, Southern Provinces, in his report for the six months ending December 31, 1931, states that the oil palm breeding, referred to in previous reports, has been proceeded with. Self-fertilised seed from high-yielding palms is now supplied, as available, for establishing plots of planted palms on native farms. A small quantity of selected oil palm seed has been recently supplied to Uganda. It has been proposed to establish some forty acres of plantation palms, with seedlings raised by self-fertilisation from high-yielding Calabar parent palms, in what are termed " Oil Palm Yield Test Blocks." Over half of this area has already been established and the bulk of the planting should be completed during the present year. The 40 acres is divided between the different Southern Agricultural stations, and the testing of all important selections is reduplicated at each station. These blocks are designed to test the inheritance of yield of the Calabar selections and, simultaneously, to test the different oil palm types (or varieties) against each other. The blocks are also expected to provide a future source of selected oil palm seed for distribution to native farmers. Selected seedlings were also supplied to plant a twenty-acre block for plantation experiments at Nkwelle agricultural station.

A paper has been accepted for the 1931 *Annual Bulletin* of the Agricultural Department, Nigeria (now in course of preparation), describing the conclusions drawn from the study of the yields of the Calabar plantation oil palms. A summary of these conclusions is given below.

(i) That the yields of mesocarp oil obtained from three areas (plots 4, 6 and 10) of the ordinary thick-shell Nigerian palm growing at Calabar, planted at different spacings, are rather less than half the yields of mesocarp oil to be obtained from the Deli type in Sumatra. This lower yield is accounted for by a lower yield of fruit per palm, a lower yield of mesocarp oil from the fruit, and by the fact that none of the Calabar plots were planted at the optimum spacing. If the estimated yields from Yves Henri are taken, these Calabar palms compare more favourably with the Deli type, and the lower yield in this instance may be accounted for by the higher oil content of the Deli fruit and by the Calabar spacings.

(ii) That the small groups of oil palms in plot 12, and to a lesser extent in plot 11, have given yields that compare very favourably with Sumatran figures. The yield figures,

in conjunction with press extraction, suggest that the green-fruited thin-shell (Afia Oku) palm is the most promising, but that the best trees of all types are capable of giving very high yields. The yield of the mantled thin-shell (Ayara Mbana) fruit form is adversely affected by the low proportion of fruit to bunch.

(iii) That the merits of the ordinary thin-shell palm, as opposed to those of the ordinary thick-shell palm, depend upon the yield and upon the proportion of the mesocarp oil that can be extracted from the fruit. With native methods of oil extraction, and with the observed differences between the yields of these two sub-types, the ordinary thick-shell form is the more valuable palm. With an improved method of oil extraction, having the efficiency of the cooker-press, the ordinary thin-shell form is slightly the more valuable, and definitely so with factory extraction. The yield of fruit per palm and the oil content of the fruit are equal in value.

(iv) That the possibility of growing thin-shell palms with a high oil content on native plantations will depend entirely upon the successful development of the cooker-press process, or of some similar improved method for oil extraction by native farmers. Without such a process thin-shell palms are less valuable than thick-shell palms on account of the lower yield of fruit per palm, the low proportion of the oil of thin-shell fruit that is recovered by native extraction methods, and of the lower yield of kernels from thin-shell fruit.

(v) That when equal weights of fruit are treated, the cooker-press process of oil extraction gives an increase of approximately 50 per cent. over the native washing method for the fruit of the ordinary thick-shell and green-fruited thick-shell palms. For the fruit of the mantled thick-shell palms, and for all the thin-shell forms, the increase obtained with the cooker-press is in the neighbourhood of 100 per cent.

(vi) That the optimum spacing for oil palms at Calabar is in the neighbourhood of twenty-seven to twenty-eight feet for the square planting and of twenty-nine feet for triangular planting.

(vii) That the maximum yield of a plantation of oil palms is reached from ten to twelve years after planting out. In the succeeding years marked annual fluctuation of yield occurs. The rise and fall in yield, occasioned by this fluctuation, appear to follow a curve. Good years seem to be followed by moderate years, then poor years followed by moderate years again. There is some indication that, on the average, the yield tends to increase slightly after the tenth to twelfth year from planting.

(viii) As the palms increase in age, fewer and heavier bunches are produced.

(ix) A plantation of palms from unselected seed presents great variation in the yield of individual trees. A few give an excellent yield, the majority a medium yield, but a considerable proportion of the palms give little or no yield.

(x) While a poor average yielding palm does not produce a high yield in any single year, medium average yielding palms can produce a very high yield, and high average yielding palms a very low yield, in a single year. A very high yield during one year from an individual palm is often followed by a very low yield the following year.

According to the report of the Chemical Branch, Southern Provinces, the process employed in pressing the palm fruit has now been considered to have been brought as closely as possible into line with native farmers' needs and the labour has been reduced to a minimum.

It has been found that by drying the nuts and fibre after the initial pressing the subsequent separation is much more readily effected. When the moisture content of the fibre has fallen from the normal 35 per cent. to about 25 per cent. the fibre no longer adheres closely to the nuts, and the conditions for separation are considerably improved.

By utilising the differences in frictional resistance of nuts and fibre to a rough surface a simple and rapid method of separation has been found. The separation is carried out on a wooden board supported at one end so as to slope at an angle of 30°–40°. The dried fruit is piled in successive lots on the high end of the board. The nuts, almost fibre free, roll to the bottom, and by agitation of the mass the speedy separation of nuts and fibre is effected. Any chunks of fibre which may roll down as separation proceeds are picked out without difficulty. In this way some 400 lb. of fruit may be separated in an hour on a 6 ft. by 3 ft. board. The drying process is carried out simultaneously with separation. The separated pulp is warmed and again pressed. In this way 80–85 per cent. of the available oil can be extracted. Efficiencies approaching 90 per cent. may be reached by third and fourth pressings, but only at the expense of a high labour-to-yield ratio.

Fibres

Cotton

Nigeria.—The Botanist, Southern Nigeria, in his report for the six months ending December 31, 1931, points out that the present cotton-breeding problem, reference to

which was made in the last report, is the attempt to combine the valuable agricultural characters of the recently introduced "Improved Ishan Strain A," of which the most serious defect is that the lint is classed as "rough" by the spinners, with the smooth line of other cottons. Through the courtesy of the Empire Cotton Growing Corporation invaluable assistance is being supplied in two directions. Firstly, Dr. Harland in Trinidad is crossing Nigerian Ishan A with Sea Island cotton and is also advising on the reduplication of this crossing which is being done locally. The first crosses have been made this season (1931–32), and some years must elapse before new strains are ready for extended trial. Secondly, certain other Ishan strains, raised from the hybrids mentioned in previous reports and at present in the single plant stage, were examined in England for the roughness character by the Spinning Tests Committee of the Corporation, and were later tested at the Shirley Institute, Didsbury. The examination and tests have proved that certain strains are free from roughness and should be acceptable to the spinners as smooth cottons. The 1931–32 and the following season should show how far these new strains breed true for the smoothness character, and how far these strains are satisfactory when judged agriculturally. The cotton this season, and especially that of the selection plot, has suffered severely from insect pests and from diseases. *Helopeltis* (*H. bergrothi*) attack, as of late years, was very prevalent. Jassid (*E. facialis*) infestation of the new strains, and also of the normally resistant Ishan strain A, has been severe. Cotton Stainers (*Dysdercus* spp.) were unusually numerous for indigenous cotton, and boll puncturing was very heavy. Much stained and damaged lint was harvested, and the Mycologist identified damage due to Internal Boll disease (*Nematospora gossypii*). Thus the strains in the cotton selection plot have undergone an abnormally severe test this season. At the time of reporting, harvesting has not been completed.

The Chief Mycologist reports that cotton seed disinfection experiments to control bacterial diseases have been carried out for the third time at Ilorin. The two previous experiments gave no significant results as regards increased yield, but that was explained by the unsatisfactory conditions of the experiment. In both cases screens of guinea corn designed to prevent spread of infection due to *Bacterium malvacearum* were non-effective, and in addition the land available for the experiments was very poor. This year better conditions prevailed. The plot available was of

better quality and the screen between the plots of cotton was effective throughout the experiment. The seed was treated by soaking in 1 per cent. Germisan for ten minutes and then drying back to the original weight in an air current at a temperature of 50° C. The screens consisted of early maize followed by guinea corn, and the land available for these screens was ridged along its length in one half and across its short side in the other half. In this way a very compact screen resulted. Disease estimations showed complete control of all seed-borne infection and later very little disease affected the plants in the treated halves. The final assessment of disease gave a mean percentage of 7·4 for the treated plots, whilst in the untreated plots there were as many as 76·3 per cent. plants showing the disease.

The final crop figures are not yet available, but taking the total to-day there is an increase of over 100 lb. of seed-cotton per acre on all the treated plots as compared with the yield on the untreated.

Sunn Hemp

Uganda.—The following results of experiments with Sunn hemp (*Crotalaria juncea*) are recorded in the report of the Serere Experiment Station for the period July 1 to December 31, 1931.

Three main rettings were made during the season, corresponding to the various stages of the plants' growth. The first, made during the early flowering period (54 days from the sowing date), gave a very poor result, estimated at only 20 lb. of fibre per acre and of very poor quality. The second, at the early fruiting period (108 days from sowing), gave round about 200 lb. per acre of an improved quality, while the third cutting, made at a more mature stage when the fruits were ripe (140 days), gave rather more than this. Apart from the first cutting the fibre length was in the neighbourhood of from 4 ft. to 4½ ft. and appeared fairly strong. The maximum seed rate from which these cuttings were made was 60 lb. per acre.

Some other rettings were made from material grown from a seed rate of 90 lb. per acre, but sown a little later (May). Better results were obtained both as regards length and quantity. The best yield from any one retting was calculated as being one of 476 lb. of fibre per acre, with fibre fully 6½ ft. in length.

Two main conclusions have been formed from this first season's cultivation ; the first, that a heavier seed rate is necessary to obtain long stems in order to get length of

fibre, and secondly that more fibre is obtained from the stems when approaching maturity. Some samples of hand-made rope and string were made during the season and sent with the fibre samples to the Imperial Institute for examination and report.

Pests and diseases were very few, and, regarding the former, even locusts left the crop alone. The only insect reported was a species of wasp in immature fruits which were eaten away. Fungoid diseases were a *Cercospora* sp. on the leaves and a saprophytic fungus (*Cladosporium herbarium*) on maturing fruits.

Drugs

Kola

Gold Coast.—It is pointed out in the Report of the Agricultural Department for the half-year July to December, 1931, that for many years the Gold Coast has exported large quantities of Kola nuts to Nigeria. Exports increased until 1924 when they reached a maximum of 7,800 tons, subsequently declining to 3,044 tons in 1929. The reason for this decline in maritime exports has been the subject of investigation by Mr. Miles (Paper XVI, *Year Book* 1930). To ascertain the exact state of the industry it was necessary to record the amount, origin and destination of Kola produced. Data on the first two heads for previous years was obtained from maritime export figures, railway traffic figures and figures from ferry checks on northern routes crossing the Volta, which were available. Data concerning the origin of Kola exported was obtained from surveys of the producing areas (vide Report for July–December 1929, this BULLETIN, 1930, **28**, 509), railway figures, and from fuller and more accurate ferry checks instituted by the Department. The following statistics were obtained:

Year.	Kola Exports—Maritime and Overland.					
	Maritime Exports.	Overland Exports from Ashanti (approx.).	Total Exports (approx.).	South by rail from Ashanti.	Total from Ashanti (approx.).	Maritime Exports not from Ashanti (approx.).
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1924 .	7,773	2,086	9,859	2,449	4,535	5,324
1925 .	6,097	2,929	9,026	2,947	5,876	3,150
1926 .	5,569	3,487	9,056	2,050	5,537	3,519
1927 .	5,128	3,387	8,515	2,006	5,393	3,122
1928 .	4,928	3,206	8,134	759	3,965	4,169
1929 .	3,018	3,937	6,955	348	4,285	2,670
1930 .	3,736	4,650	8,386	753	5,403	2,983

The main conclusion was that while maritime exports had declined by 2,000 or 3,000 tons, the overland exports had increased by some 1,500 tons. On balance the total exports had decreased by 700 to 1,000 tons, but the decline was not nearly so great as the maritime exports indicated. The decline of the maritime trade was due to various causes. Consumption in the Northern Provinces of Nigeria was probably affected adversely by the low prices of exportable products and the increased production in the Southern Provinces of Nigeria. The value of the nuts had consequently declined, and the maritime trade had become less attractive to producers. The indications for the future therefore are that maritime exports, i.e. trade from the colony, will continue to decline while the trade overland to the north, i.e. Ashanti trade, will be maintained and may increase. As the trees are long-lived, potential production will remain unaltered.

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Annual Report of the Poultry Expert to the Government, Punjab, Gurdaspur, for the Year ending June 30, 1930. Pp. 3, 13¼ × 8¼. (Lahore: Superintendent, Government Printing, 1931.) Price Re. 0–2–0 or 3*d.*

Poultry Keeping on the General Farm. *Bull. No.* 8, *Min. Agric. and Fisheries.* Pp. 34, 9¾ × 6. (London: H.M. Stationery Office, 1931.) Price 8*d.* Prepared as a guidance for farmers who are contemplating either commencing poultry keeping or extending their present stock and equipment.

The Poultry Industry. Egg Marketing. By V. Liversage and W. D. D. Jardine. *Bull. No.* 2 *of* 1932, *Dept. Agric., Kenya.* Pp. 25, 9¾ × 6¼. (Nairobi: Government Printer, 1931.) Price cts. 50.

Turkey Raising in California. By W. L. McFarlane, W. E. Lloyd and G. Merrill. *Circ.* 58, *California Agric. Extension Serv.* Pp. 64, 9 × 6. (Berkeley: University of California, 1931.)

Nectar and Pollen Plants of California. By G. H. Vansell. *Bull.* 517, *California Agric. Exper. Sta.* Pp. 60, 9 × 6. (Berkeley: University of California, 1931.)

Report of the Economic Advisory Council Committee on the Fishing Industry of Great Britain. Pp. 204, 9¾ × 6. (London: H.M. Stationery Office, 1932.) Price 3*s.*

Annual Report on the Fisheries of New South Wales for the Year 1930. Pp. 13, 13 × 8¼. (Sydney: Government Printer, 1931.)

Sardine Canning in Britain. *Food Manufacture* (1932, **7**, 111–114).

Report and Recommendation on Trochus and Pearl Buttons by the Tariff Board of the Commonwealth of Australia, November 11, 1931. Pp. 12, 13¼ × 8¼. (Canberra: Government Printer, 1932.) Price 9*d.*

Insect Damage to Hides and Skins. By B. Smit. *Reprint No.* 27, 1931, *Dept. Agric., Union of S. Africa.* Pp. 3, 9½ × 7¼. (Pretoria: Government Printer, 1931.)

Forestry

General

Report of the Forestry Products Research Board, Department of Scientific and Industrial Research, for the Year 1930. Pp. 52, 9¾ × 7¼. (London: H.M. Stationery Office, 1932.) Price 4*s.*

Annual Report of the Woods and Forests Department, South Australia, for the Year ended June 30, 1931. Pp. 9, 13¼ × 8½. (Adelaide: Government Printer, 1932.)

Twelfth Annual Report of the Forests Commission of Victoria, Australia, for the Financial Year, 1930–31. Pp. 16, 13½ × 8¼. (Melbourne: Government Printer, 1931.) Price 1*s.*

Forestry in Fiji. By R. A. Sykes. *Agric. Journ., Fiji* (1931, **4**, 169–174). Distribution of forests and principal woods.

Annual Return of Statistics Relating to Forest Administration in British India for the Year 1929–30. Pp. 31, 13 × 8¼. (Calcutta: Government of India Central Publication Branch, 1932.) Price Re. 1–8 or 2*s.* 6*d.*

Report of Forest Administration in Baluchistan for the Year 1930–31. Pp. 49, 9¾ × 6¼. (Calcutta: Government of India Central Publication Branch, 1932.) Price Rs. 6–6 or 10*s.*

Annual Progress Report on Forest Administration in the Province of Bihar and Orissa for the Year 1930–31. Pp. 75, 13½ × 8½. (Patna: Superintendent, Government Printing, 1931.) Price Rs. 3.

Report on Forest Administration in Burma (excluding the Federated Shan States) for the Year ending March 31, 1931. Pp. 283, 9¾ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery, 1932.) Price Rs. 3–8 or 5*s.* 3*d.*

Report on the Forest Administration in the Utilization Circle, Burma, for the Year ended March 31, 1931. Pp. 61, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1931.) Price Rs. 3 or 4*s.* 6*d.*

Progress Report of Forest Administration in Coorg for 1930–31. Pp. 32, 9¾ × 6¼. (Bangalore: Mysore Residency Press, 1931.) Price Re. 1.

Administration Report of the Forest Department of the Madras Presidency for the Year ending March 31, 1931. Vol. I. Pp. 255, 9¾ × 6¼. (Madras: Superintendent, Government Press, 1932.) Price Rs. 2.

Administration Report of the Forest Department of the Madras Presidency for the Year ending March 31, 1931. Vol. II. Pp. 323, 9¾ × 6. (Madras: Superintendent, Government Press, 1932.) Price Rs. 2–4–0.

Annual Progress Report on Forest Administration in the United Provinces for the Period April 1, 1930, to March 31, 1931. Pp. 74,

$9\frac{3}{4} \times 6\frac{1}{4}$. (Allahabad: Superintendent, Printing and Stationery, 1931.) Price Rs. 2–12–0.

Report on Forest Administration, Federated Malay States, for the Year 1930. Pp. 65, $13\frac{1}{2} \times 8\frac{1}{4}$. (Kuala Lumpur: Government Press, 1931.)

Report of the Department of Agriculture and Forests, Palestine, for the Year 1927 to 1930. Pp. 167, $13 \times 8\frac{1}{4}$. (Jerusalem: Printing and Stationery Office, 1931.) Price 100 mils.

Annual Report of the Department of Forestry, Union of South Africa, for the Year ended March 31, 1931. Pp. 56, $13 \times 8\frac{1}{4}$. (Pretoria: Government Printer, 1932.) Price 3*s*.

Notes on *Pinus longifolia* Roxb. The Plantation in Dehra Dun and the Central Provinces and Miscellaneous Seed Studies. By H. G. Champion and B. D. Pant. *Indian For. Rec., Silviculture Series*, Vol. XVI, Part VII. Pp. 25, $9\frac{3}{4} \times 7\frac{1}{4}$. (Calcutta: Government of India Central Publication Branch, 1932). Price Re. 1–10 or 2*s*. 9*d*.

Slush Disposal in the Western Yellow Pine Forests of Oregon and Washington. By T. T. Munger and R. H. Westveld. *Tech. Bull. No.* 259, *U.S. Dept. Agric.* Pp. 57, $9\frac{1}{4} \times 5\frac{3}{4}$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 20 cents.

Studies on the Germination of Seed of the Black Wattle (*Acacia mollissima*) and the Green Wattle (*Acacia decurrens normalis*). By J. B. Osborn and E. Osborn. *South African Journ. Sci.* (1931, **28**, 222–237).

Insects Infesting *Pinus radiata* in New Zealand. By A. F. Clark. *New Zealand Journ. Sci. and Tech.* (1932, **13**, 235–243).

The Satin Moth in British Columbia. By R. Glendenning. *Pamphlet No.* 50, *New Series, Dept. Agric., Canada.* Pp. 15, $9\frac{3}{4} \times 6\frac{1}{2}$. (Ottawa: King's Printer, 1932.) Deals with the occurrence, life history and habits, and methods of control of this pest of poplars.

Timbers

Census of the Wood-Using Industries of Canada, 1929. Pp. 139, $9\frac{3}{4} \times 6\frac{1}{2}$. (Ottawa: King's Printer, 1932.) Price 25 cents. In English and French.

The Anatomical Structure of Certain Ceylon Woods. By C. P. Jayawardana. *Ann. Roy. Bot. Gardens, Peradeniya* (1932, **11**, pt. 4, 307–317).

Identification of Timbers Available in the Moist Deciduous to Savannah Forests in Lagos Colony, Abeokuta, Ondo and Oyo Provinces. Pp. 10, $13\frac{1}{4} \times 8\frac{1}{2}$. (Lagos: Government Printer, 1931.)

The Identification of Wood by Chemical Means. Part I. By H. E. Dadswell. *Pamphlet No.* 20, *Counc. Sci. Indust. Res., Australia.* Pp. 16, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1931.)

The Properties and Uses of Insignis Pine (*Pinus radiata*). By C. E. Dixon. *Timber Growers' Quart. Rev., N. Zealand* (1931, No. 7, 7–17).

The Properties and Uses of Rimu (*Dacrydium cupressinum*). By W. C. Ward. *Leaf. No.* 17, *Forest Prod., New Zealand State For. Serv.* Pp. 8, $9\frac{3}{4} \times 6$. (Wellington: Government Printer, 1931.)

Durability Tests on Untreated Indian Timbers. By F. J. Popham. *Indian Forester* (1932, **58**, 9–19).

Tests in the Rangoon River on the Damage by Marine Borers to Various Woods, including Burma Teak and British Guiana Greenheart, Creosoted and Untreated. *Burma For. Bull. No.* 28. Pp. 10, $9\frac{1}{2} \times 6\frac{1}{4}$. (Rangoon: Superintendent Government Printing and Stationery, 1932.) Price 8 Annas or 9*d*.

The Composition of Philippine Woods. II. Anubing (*Artocarpus cumingiana*), Balakat (*Ziziphus talanai*), Malaikmo (*Celtis philippinensis*),

Balakat-gubat (*Sapium luzonicum*), Bolongeta (*Diospyros pilosantera*), and Santol (*Sandoricum koetjape*). By F. M. Yenko, L. Baens, A. P. West and H. M. Curran. *Philippine Journ. Sci.* (1932, **47**, 343–348).

The Nail-Holding Power of the Principal Philippine Commercial Woods. By J. C. Espinosa. *Philippine Journ. Sci.* (1932, **47**, 425–430).

An Investigation of Certain Australian Hardwoods for Use in Rollers, Bobbins, etc. By H. E. Dadswell. *Journ. Counc. Sci. Indust. Res., Australia* (1932, **5**, 59–60).

Materials for Chemical Plant Construction. I. Timber. By A. H. Loveless. *Indust. Chem.* (1932, **8**, 104–106).

An Experimental Study of the Thermal Capacity of Some Fuel Woods. By R. C. Malhotra. *Indian Forester* (1932, **58**, 124–132).

Experiments on Moisture in Timber. By M. B. Welch. *Journ. and Proc. Roy. Soc., N.S. Wales* (1930, **64**, 337–351). Results of a series of experiments on the moisture content at different times of the year of certain Australian flooring timbers. It was shown that a definite relationship exists between the atmospheric humidity and the moisture content of the wood.

Wood Borers in Australia. Part I. Lyctus or Powder Post Beetle. *Trade Circ. No.* 6, *Div. For. Products, Counc. Sci. Indust. Res., Australia.* Pp. 14, 9½ × 6. (Melbourne: Government Printer, 1931.) Deals with the occurrence, life history, damage caused and methods of eradication.

The Preservative Treatment of Fence Posts (with Particular Reference to Western Australia). By J. E. Cummins. *Pamphlet No.* 24, *Counc. Sci. Indust. Res., Australia.* Pp. 34, 9½ × 6. (Melbourne: Government Printer, 1932.)

Effect of Chemical Treatment on Wood Permeability. By A. J. Stamm. *Journ. Indust. and Eng. Chem.* (1932, **24**, 51–53). An account of experiments with Douglas Fir.

Wood Chemicals. Further Aspects of the Industry of Hardwood Distillation. By M. Schofield. *Indust. Chemist* (1931, **7**, 505–507.)

Wood Taint in Butter: Experiments on its Prevention. By W. J. Wiley. *Journ. Counc. Sci. Indust. Res., Australia* (1932, **5**, 15–24). Experiments with various wrapping materials and coatings for wood.

Wood Taint in Butter: Laboratory Experiments with Special Reference to *Pinus radiata* (*insignis*) and Hoop Pine (*A. cunninghamii*). By W. J. Wiley. *Journ. Counc. Sci. Indust. Res., Australia* (1932, **5**, 5–14). Also issued as *Reprint No.* 5, *Division of Forest Products.*

Gums and Resins

Notes on Lac Cultivation in Hosur Plateau. By S. Rangaswami. *Indian Forester* (1932, **58**, 157–172).

Nature and Constitution of Shellac. IV. A study of the Saponification Number. By W. F. Whitmore, H. Weinberger and W. H. Gardner. *Journ. Indust. Eng. Chem., Analytical Ed.* (1932, **4**, 48–51).

More Turpentine, Less Scar, Better Pine. By E. Gerry. *Leaflet No.* 83, *U.S. Dept. Agric.* Pp. 4, 9¼ × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1931.) Price 5 cents. Deals with the advantages of low chipping of trees to yield turpentine.

Crystallized and Distilled Rosin from Philippine Pine Trees (*Pinus insularis* Endlicher). By S. S. Tanchico and A. P. West. *Philippine Journ. Sci.* (1931, **47**, 481–484).

An Aldehyde Rosin Oil from Philippine Pine Trees (*Pinus insularis* Endlicher). By S. S. Tanchico and A. P. West. *Philippine Journ. Sci.* (1932, **48**, 1–3).

Physical Properties of Wood Rosin. *Journ. Indust. and Eng. Chem.* (1932, **24**, 168–173).

Tanning Materials

Chinese Vegetable Tanning Materials. By Y. C. Tao. *Journ. Intern. Soc. Leather Trades Chemists* (1932, **16**, 102–104). Contains a list of tanning materials, giving their tannin and non-tannin content.

Permanganate-Hide-Powder Graph for Tannin Analysis of Wood Barks. Results by the modified Hide-Powder Method, obtained from the Permanganate Determination. By L. Baens and A. P. West. *Philippine Journ. Sci.* (1932, **47**, 467–477).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

Education for Empire Settlement. A Study of Juvenile Migration. By Alex. G. Scholes, B.A. (Melb.), Dip. Ed. (Melb.), Ph.D. (Edin.). Pp. xii + 250, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Longmans, Green & Co., Ltd., 1932.) Price 7*s*. 6*d*.

This is an admirable survey of the conditions of juvenile migration from Great Britain, starting with the transportation of young delinquents which began about a century ago. It is well written and copiously annotated, and though under present economic conditions in the Dominions its main subject may be of academic rather than immediate practical interest, it should prove of considerable value to students of sociology and readers specially concerned with work among the young.

Le Cotonnier. III. Egrenage et Pressage du Coton, Conditionnement et Tare des Balles de Coton, Etude Economique sur l'Industrie de l'Egrenage, Système de Comptabilité pour Usines d'Egrenage. By Ray C. P. Boone. Pp. 259, $10 \times 6\frac{1}{2}$. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1932.) Price 75 Frs.

The first two volumes of this comprehensive work, which deal with the cotton plant and its cultivation, have already been noticed in this Bulletin (1929, **27**, 427; 1931, **29**, 96).

In the new volume the author deals with the various stages through which the raw cotton passes from its arrival at the ginnery to its exit in the form of bales.

After referring to the storage of the seed-cotton, the author describes in great detail the two classes of ginning

machines, viz. roller gins and saw gins. An account is given of the machinery used to clean the seed-cotton before it enters the gin, and full particulars are supplied regarding de-lintering. Information is furnished regarding the most modern types of ginneries, the most up-to-date modes of operating them and the different kinds of baling presses. The work concludes with an economic study of the methods of accounting adopted in the ginneries of the United States.

The book has been written in a most complete and thorough manner, is profusely illustrated and contains a useful bibliography.

SISAL UND ANDERE AGAVEN: Die Kultur der Agaven und der Fourcroyas unter besonderer Berücksichtigung der Agave sisalana P.: Ihre Ernte und Aufbereitung sowie die Verwertung der Produkte. By W. Hoffmann. Pp. 60, $8\frac{1}{4} \times 5$. (Hamburg: Tropenverlag Fr. W. Thaden, 1932.) Price M. 3.60.

The author of this little work is Agricultural Engineer and Director of Plantations in Madagascar, where sisal cultivation was first undertaken experimentally in 1905. Interest in the crop has gradually increased and large plantations have now been established on the west coast of the island, where the production in a recent year amounted to about 600 tons. The information supplied in the book relates chiefly to the practice adopted in Madagascar, and for this reason it tends to lack the comprehensiveness of a general text-book, although it will nevertheless be of considerable interest to sisal planters.

The author appears to be quite out of touch with recent market conditions, as, after mentioning that in December 1929 sisal was quoted at £36 10*s.* per ton, he makes the remarkable mis-statement that the price of the fibre, unlike that of most other Colonial products, has not diminished, but on the average has risen by about £10–£15, and that most planters consider this price will be maintained for several years although it may be expected to fall subsequently.

MANILAHANF—MUSA TEXTILIS. KULTUR UND AUFBEREITUNG. By H. V. Costenoble. Pp. 18, $8\frac{1}{4} \times 5$. (Hamburg: Tropenverlag Fr. W. Thaden, 1932.) Price M. 1.80.

The author of this booklet is Farm Adviser to the Culion Leper Colony in the Philippines, in which capacity he has had personal experience in Manila hemp production.

The account which he has given of the cultivation of the plant and the preparation of the fibre, although concise, is essentially practical.

After pointing out that the plant is indigenous to the Philippines, he refers to the great number of varieties (which he estimates at about 70) that are grown, and to the fact that each makes special individual demands with regard to soil and rainfall and therefore flourishes best in one particular district. It is suggested that this remarkable sensitiveness of the plant to small differences in local conditions is the cause of the delay which has occurred in the extension of the cultivation to countries outside the Philippines, it being only after endeavours extending over many years that the plant has become acclimatised in Sumatra and in South America.

The conditions necessary for the successful growth of *Musa textilis* and the manurial requirements of the plant are discussed, methods of propagation and the establishment of plantations are described, and information is supplied regarding the harvesting of the leaf sheaths and the extraction of the fibre. Brief reference is also made to the compulsory grading scheme in force in the Philippines and the uses to which the fibre is applied. The work concludes with a short account of the diseases and pests by which the plant is liable to be attacked.

CONIFERS IN CULTIVATION: The Report of the Conifer Conference held by the Royal Horticultural Society, November 10–12, 1931. Edited by F. J. Chittenden, F.L.S., V.M.H. Pp. 634, $9\frac{3}{4} \times 6\frac{1}{4}$. (London: The Royal Horticultural Society, 1932.) Price 21*s*.

Amongst the principal objects of the Conference, the report on which is contained in this volume, were to collect experiences regarding the many coniferous plants introduced as a result of expeditions to China, North Burma, Tibet, etc., and to revise previous conclusions on the cultural possibilities of various conifers. Several of the papers deal with conifers in their horticultural and botanical aspects. Others will be of special interest to the forester at home and in certain countries overseas. Amongst the latter the following call for notice.

Sir John Stirling-Maxwell, Bt., K.T., in the *Influence of Exotic Conifers on Silviculture in the British Isles*, gives an account of the results obtained in planting for timber many foreign conifers.

Mr. A. C. Forbes discusses " Some Problems connected with the Natural Reproduction and Survival of New

Zealand Conifers." Mr. W. Dallimore's contribution on "The Economic Value of the Coniferæ," is a useful summary of information not only on the timbers obtained from the various coniferous trees, but also on their other economic products, such as resins, oleo-resins, essential oils and drugs with which Professor H. E. Armstrong, F.R.S., also deals in his interesting paper on "Conifer Chemistry."

"The Conifers of Kenya," by Mr. H. M. Gardiner, describes conditions in a tropical country exceptional in having its own coniferous soft wood supply, and Mr. C. E. Legat summarises results obtained from "The Cultivation of Exotic Conifers in South Africa" for economic purposes. The volume contains 79 full-page plates, mostly of coniferous trees, grown either as ornamentals or as timber trees, which add greatly to its interest and value.

THE WASTE PRODUCTS OF AGRICULTURE. THEIR UTILIZATION AS HUMUS. By Albert Howard, C.I.E., M.A., and Yeshwant D. Wad, M.Sc. Pp. xiv + 167, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Humphrey Milford, Oxford University Press, 1931.) Price *7s. 6d.*

The authors of this work are respectively Director of the Institute of Plant Industry, Indore, and Chief Assistant in Chemistry in the same Institute. They have here presented observations on the principal agricultural systems now in vogue and the place of organic matter as a fertiliser, together with an account of the preparing of compost by the "Indore" method. They express the view that the "Indore" process could be adopted not only in tropical and sub-tropical countries, but also in the temperate zone, and that apart from its direct value as a source of suitable manures, it would prove useful from the standpoint of rural hygiene.

The treatise itself, and the useful bibliographies appended to each chapter, should be of interest to many agriculturists desirous of improving local supplies of organic manures.

DER KATIONEN- UND WASSERHAUSHALT DES MINERALBODENS. By Dr. P. Vageler. Pp. vi + 336, $10 \times 6\frac{3}{4}$. (Berlin: Verlag von Julius Springer, 1932.) Price RM. 28.

The introduction to this book states that the problems met with in scientific agriculture, considered as a whole and not limited to any particular set of conditions, can be grouped under three main headings: firstly, the respects, in any defined climatic conditions, in which "good" and "bad" or productive and unproductive soils differ in their

chemical and physical aspects ; secondly, the means by which, under the given climatic conditions, unfavourable chemical and physical conditions in the soil can be influenced and altered by tillage, manuring and amelioration in such a manner that the outlay involved bears a reasonable relation to the benefits obtained ; and thirdly, in any particular soil, the means by which the unfavourable influence of climate can be overcome by raising or lowering the water content, and the physical and chemical conditions necessary to raise the economic results to a maximum. The author then proceeds to consider the physical principles involved in a study of the relationships between the soil and water, the influence of the different cations in the colloidal complex of the soil and the effects of movement of water as influenced by the soil and by the plant.

The final chapter gives practical details of methods of examination of soils, including the examination of profiles and the taking of samples, the preparation of the sample for examination in the laboratory, and physical and chemical methods of examination, the latter being limited in the main to the water-soluble and exchangeable bases.

The greater part of the book appears to be of a highly specialised and largely theoretical character, and it should prove an excellent work for those interested in this aspect of the subject.

PRINCIPLES OF SOIL MICROBIOLOGY. By Selman A. Waksman. Pp. xxviii + 894, 9 × 6. Second edition, thoroughly revised. (London : Baillière, Tindall & Cox, 1931.) Price 52*s*. 6*d*.

The first edition of this book, although published only four years ago (see this BULLETIN, 1927, **25**, 352), has already become established as a classic and an indispensable work of reference in its own sphere. This new edition follows the same general arrangement as before. A large amount of recently acquired knowledge has been incorporated and this has necessitated the re-writing of some chapters of the previous edition as well as the inclusion of new chapters. The revised sections include those dealing with the mycorrhiza fungi and with the soil as a medium for plant and animal parasites. New chapters have been added, on the rôle of micro-organisms in the decomposition of organic matter in green manures and stable manures, and in the formation and decomposition of peat and forest soils, and on the relations between the growth of higher plants and the activities of micro-organisms in the soil. In order to keep the work within reasonable limits of size, a certain

amount of material not bearing directly upon the subject has had to be omitted, and certain chapters have been condensed so as to avoid duplication. As in the previous edition, particular emphasis has been placed upon the interdependence of the activities of micro-organisms and the chemical transformations taking place in the soil. The new additional matter tends to lay further stress on the influence of the soil as a medium upon the nature and activities of the micro-organisms.

This new edition is thoroughly up-to-date, and should maintain the book's pre-eminence in its own field.

LAND DRAINAGE. By W. L. Powers, Ph.D., and T. A. H. Teeter, B.S. (C.E.). Pp. x + 353, $8\frac{1}{4} \times 5\frac{1}{2}$. Second edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 20*s*.

This is the second edition of a book of which the first edition was reviewed in this BULLETIN (1922, **20**, 272–3). It has been enlarged and brought up-to-date, particularly with regard to developments in American drainage practice, and the authors' aim, as stated in the new preface, has been "to adhere to the plan of providing a concise drainage text, with the least practicable encroachment upon other related fields." The new edition should start the book on a fresh period of utility to farmers, irrigation engineers and others who have to deal with agricultural drainage problems.

INTRODUCTION TO AGRICULTURAL BIOCHEMISTRY. By R. Adams Dutcher and Dennis E. Haley. Pp. x + 494, 9 + 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 28*s*.

Agricultural biochemistry is a wide field to attempt to cover, but as the authors, who are respectively Professor of Agricultural and Biological Chemistry, and Professor of Soil and Phytochemistry in the Pennsylvania State College, say in their preface, the volume is an outgrowth of lectures given over a period of nearly twenty years. They are thus fully conversant not only with the subject but also with its presentation in a form of interest and use to agricultural students.

In Part I, after tracing the historical development of agricultural chemistry, separate chapters are devoted to such subjects as the chemistry of living matter, the carbohydrates, fats, proteins, enzymes and the physical state of matter.

Part II deals with the plant chiefly in relation to the soil, fertilisers, assimilation of various nutrients, etc.; insecticides and fungicides are also discussed.

In Part II, devoted to the animal foods, feeding stuffs, digestion, metabolic changes, etc., are well dealt with. Of special interest at present are the chapters on the biological response to food and the full treatment of the occurrence and functions of the chief vitamins.

The book should prove useful for general reference to all interested in the increasingly important part played by chemistry, not only in modern agricultural science, but in our own lives and those of our domesticated animals and plants.

GROWTH AND THE DEVELOPMENT OF MUTTON QUALITIES IN THE SHEEP. A Survey of the Problems Involved in Meat Production. By John Hammond, M.A., with a section in conjunction with A. B. Appleton, M.A., M.B. Pp. xxvi + 597, $9\frac{3}{4} \times 6\frac{1}{4}$. (Edinburgh and London: Oliver & Boyd, 1932.) Price 42*s*.

The production of meat is the concern of the breeder, the feeder and the butcher, three people whose points of view are different but whose co-operation is necessary in order that the best results may be secured to their mutual advantage. The proper correlation of their different aims depends largely on a scientific understanding of the factors involved, and the researches of which this monograph is an account were undertaken in the hope that the application of biological science to the problems of the meat producer might lead to improvements in the industry such as were effected by scientific endeavour in the related problems of wheat-growing and bread-making.

The first part of the book deals with a study of rate of growth, and the factors affecting it, in the Cambridge University flock of Suffolk sheep; the second part with the relative development of different organs (carcase composition); the third with the development of different parts of the skeleton (body conformation); the fourth with variations in proportions of muscle, fat and bone.

The fifth and last part, in which the two authors have collaborated, is entitled "Study of the Leg of Mutton." This section, covering nearly 200 pages, gives a detailed study of the development of the different bones and muscles, and the distribution of fat, as affected by age, sex, breed, domestication and degree of fatness, as well as of the chemical composition and histological characters of the muscles, and must surely contain the last word on the leg of mutton as a subject of scientific investigation. The

question of quality or " edibility " is less susceptible to the methods of the laboratory, but it has been treated as an important part of the investigation, and we are presented with the spectacle of a leg of mutton of recorded antecedents, cooked in one of the College kitchens at Cambridge, dissected when cold into its separate muscles, slices of which are put before a number of tasters who are asked to arrange them in order of tenderness and flavour. It is perhaps not to be expected that the results so obtained should be reducible to a set of convenient formulæ, but the investigation has undoubtedly gone far towards a correlation between the qualities making for " edibility " and the factors on which they depend.

The book admirably fulfils its purpose as one of a series of " Biological Monographs and Manuals," whose aim is to provide authoritative accounts by investigators of their researches in particular fields of enquiry, showing their relation to what has already been done and to problems that remain to be solved.

A MANUAL OF BEEKEEPING FOR ENGLISH-SPEAKING BEEKEEPERS. By E. B. Wedmore, M.I.E.E., F.Inst.P. Pp. xxiv + 413, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Edward Arnold & Co., 1932.) Price 15*s*.

This is a publication for beekeepers who are already well grounded in their subject and wish to gain a more exhaustive knowledge of all its branches. The aim has been to compress into one volume an amount of information which if presented in the ordinary text-book style might be expected to occupy several volumes. It follows that few words are wasted on such matters as historical origins or on considerations of arguments supporting or opposing different views or methods, and the work of past investigators is acknowledged collectively " once for all " in the preface.

There is, indeed, in the last section of the book, headed " Inventions and Discoveries," a catalogue of persons who have added to useful knowledge in relation to bees and beekeeping, and mention is here made, among others, of Swammerdam, who discovered that queens could be reared from workers, Dzierzon, described by the author as the discoverer of parthenogenesis, Langstroth, the inventor of the frame known by his name, and Hruschka, to whom the centrifugal honey extractor is attributed.

Some space is devoted to the Theory of Swarming, but even this section shows little departure from the style indicated above.

From all of which it will appear that the book is conceived on utilitarian lines, and the beekeeper who buys it with a view to obtaining the greatest amount of useful knowledge in convenient compass will not be disappointed.

Emphasis is laid on the fact, indicated in the title, that the work is not written for the conditions prevailing in any one country, but gives such guidance as will enable the reader to select the best methods for his particular circumstances wherever he may be situated.

In such a work as this a good index is obviously of the first importance, and in this respect also the book is well furnished.

Chemical Engineering and Chemical Catalogue. Edited by D. M. Newitt, Ph.D., B.Sc., F.I.C., A.R.C.S., A.I.C., A.I.Chem.E. Pp. lxxiii + 270, $10\frac{3}{4} \times 8\frac{1}{2}$. Eighth Edition. (London: Leonard Hill, Ltd., 1932.) Price 10*s*.

Notice of earlier editions of this publication have appeared in this Bulletin (1929, **27**, 439; 1930, **28**, 261). The present issue is published at a lower price, and in view of the mass of practical information which it contains and its utility as a reference book for the trades concerned, this should lead to an increased circulation, the more so as the most valuable section, viz. the classified index of raw materials, products, and plant, and firms supplying them, has been greatly extended. A useful feature of the edition is the inclusion of a German-English vocabulary.

In addition to the foregoing and other items, including a mass of formulæ, tables of figures and manufacturing data (some of which, as previously pointed out in this Bulletin, seem hardly necessary in a work of this type) the book contains a voluminous technical bibliography occupying over 50 pages.

Rubber Information: An Industrial and Commercial Compendium. Edited by H. B. Cronshaw, B.A., Ph.D., A.I.C. Pp. lxxiii + 263, $10\frac{3}{4} \times 8\frac{1}{2}$. (London: Leonard Hill, Ltd., 1932.) Price 10*s*.

This is also a new edition of a work previously noticed in this Bulletin (1930, **28**, 399). Its scope extends beyond the rubber industry, as it includes the whole of the classified index and bibliography contained in the foregoing *Chemical Engineering and Chemical Catalogue*, but as regards rubber in particular the volume includes (in the form of a " Rubber Dictionary ") a useful encyclopædia of rubber terminology occupying nearly 70 pages, as well as a

dictionary of "compounding ingredients and other rubber chemicals" and a list of plantation companies; the whole forming a very practical work of reference for the rubber trade and allied enterprises.

INTRODUCTION TO CERAMIC INDUSTRIES. By Hirendra Nath Bose, M.Sc. Pp. iv. + 304, 7¼ × 4¾. (Calcutta: R. P. Mitra & Son, 1930.) Price 6*s*.

This book gives in a concise form a description of the main branches of the ceramic industry. It comprises ten chapters, dealing respectively with raw materials; methods of formation; glazes and colours; refractories; porcelains; stonewares; earthenwares; terra-cotta; fuel, kilns, pyrometry; and ceramic calculations. There is also a short appendix of tables, etc., with a list of occurrences of china clay in India.

In view of the small size of the book the treatment of each of the subjects enumerated is necessarily brief, but a successful endeavour has been made to give an outline of the theory and practice of the different operations and processes described.

The book should be of service to those wishing to obtain a general idea of clay-working practice, or to those practical potters who work under more or less rule-of-thumb methods and desire a not too advanced introduction to more scientific procedure.

There are some loose statements and inconsistencies, e.g. those with reference to china clay and its plasticity on pages 13 and 19, and the English punctuation and spelling are also at times somewhat faulty. These defects, however, do not detract very seriously from the merits of the book as a preliminary guide to a more detailed study of ceramics.

BOOKS RECEIVED FOR NOTICE

HANDBOOK OF COMMERCIAL GEOGRAPHY. By Geo. G. Chisholm, M.A., B.Sc., Hon. LL.D. Twelfth Edition, revised and edited by L. Dudley Stamp, D.Sc., B.A. Pp. xv + 825, 8½ × 5½. (London: Longmans, Green & Co., Ltd., 1932.) Price 25*s*.

PIONEER SETTLEMENT. Co-operative Studies by Twenty-six Authors. Pp. vi + 473, 10 × 6¾. (New York: American Geographical Society, 1932.)

An Atlas of the Progress in Nawanagar State accomplished since the Accession in March, 1907, of Lieutenant-Colonel His Highness Shri Sir Ranjitsinhji Vibhaji Maharaja Jam Saheb of Nawanagar, G.C.S.I., G.B.E. By John de la Valette. Pp. v + 30, and twenty-one charts, 11 × 8¾. (London: East & West, Ltd.) Price 10*s*. 6*d*.

Agricultural Policy in South Africa. By Hubert D. Leppan. Pp. 101, 8½ × 5½. (Johannesburg: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1931.) Price 6*s*.

Vegetable Fats and Oils. By George S. Jamieson, Ph.D. Pp. 444, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1932.) Price $6.50.

The Economic Botany of Cacao. A Critical Survey of the Literature to the end of 1930. By E. E. Cheesman, M.Sc., A.R.C.S. Pp. 16, 11 × 8½. Supplement to *Tropical Agriculture*, June 1932. (Trinidad: Government Printing Office, 1932.) Price 1*s*.

A Study of Empire Wool Production. Being a Survey of Conditions in New Zealand, Australia, South Africa, Southern Rhodesia, Kenya, Canada, Irish Free State, etc. By J. E. Nichols. Pp. 148, 9¾ × 6¼. (Leeds: Wool Industries Research Association, 1932.) Price 5*s*.

Lumber and its Uses. By Royal S. Kellogg. Fourth Edition, revised, enlarged, and entirely re-set. Pp. xix + 378, 8¾ × 5¾. (New York: Scientific Book Corporation, 1931.) Price 18*s*.

The Determination of the Moisture Content of Timber. By R. A. G. Knight, B.Sc. Department of Scientific and Industrial Research, Forest Products Research, Bulletin No. 14. Pp. iv + 11, 9¾ × 7¼. (London: His Majesty's Stationery Office, 1932.) Price 1*s*.

Directory of Paper Makers of Great Britain and Ireland for 1932. Pp. 261, 10¼ × 7¼. (London: Marchant Singer & Co., 1932.) Price 5*s*.

Fertilizers and Food Production on Arable and Grass Land. By Sir Frederick Keeble, C.B.E., Sc.D., F.R.S. Pp. ix + 196, 7¼ × 5. (London: Humphrey Milford, Oxford University Press, 1932.) Price 5*s*.

METHODEN FÜR DIE UNTERSUCHUNG DES BODENS. By Dr. O. Lemmermann. Teil I. Pp. 90, $9\frac{1}{4} \times 6\frac{1}{4}$. (Berlin: Verlag Chemie, 1932.) Price MK.6.

BAUXITE AND ALUMINOUS LATERITE. By Cyril S. Fox, D.Sc., M.I.M.E., F.G.S. Pp. xxxi + 312, $10 \times 6\frac{1}{4}$. Second Edition, partly rewritten and enlarged. (London: Crosby Lockwood & Son, 1932.) Price 30*s*.

THE EXAMINATION OF FRAGMENTAL ROCKS. By Frederick G. Tickell. Pp. x + 127, 10×7. (California: Stanford University Press; London: Humphrey Milford, Oxford University Press, 1932.) Price 29*s*.

FUEL TESTING: LABORATORY METHODS IN FUEL TECHNOLOGY. By Godfrey W. Himus, B.Sc., A.R.C.S., D.I.C., A.I.C., M.I.Chem.E. Pp. x + 257, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill, Limited, 1932.) Price 15*s*.

THE SCIENTIFIC PRINCIPLES OF PETROLEUM TECHNOLOGY. By Dr. Leo Gurwitsch and Harold Moore, M.Sc.Tech., M.I.Petrol.Tech., F.C.S., A.I.Mech.E. New Edition. Pp. xii + 572, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Chapman & Hall, Ltd., 1932.) Price 30*s*.

THE QUANTITY AND SOURCES OF OUR PETROLEUM SUPPLIES. By John Muirhead Macfarlane, D.Sc., LL.D., Litt.D. Pp. 250, $8\frac{3}{4} \times 5\frac{3}{4}$. (Philadelphia: Noel Printing Company, Inc., 1931.)

THE POTASH INDUSTRY. A Study in State Control. By George Ward Stocking. Pp. x + 343, $7\frac{3}{4} \times 5\frac{1}{4}$. (New York: Richard R. Smith, Inc., 1931.) Price $3.00.

A NEW GEOLOGICAL MAP OF THE COMMONWEALTH OF AUSTRALIA. Scale 1 : 2,990,000 (1″ × 47·2 miles approx.). With a volume of Explanatory Notes, by Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., M.A., F.R.S. (pp. 177, $10 \times 6\frac{1}{4}$). Price, unmounted, in four sheets, together with the Volume of Notes, 20*s*. net; mounted on linen and dissected, in case, together with bound Volume of Notes, 42*s*. net. (London: Edward Arnold & Co., 1932.)

BULLETIN OF THE NATIONAL RESEARCH COUNCIL, Number 86. Bibliography of Bibliographies on Chemistry and Chemical Technology. Second Supplement, 1929–1931. Compiled by Clarence J. West and D. D. Berolzheimer. Pp. 150, $9\frac{1}{2} \times 6\frac{3}{4}$. (Washington : National Research Council, 1932.) Price $1.50.

COLLOID CHEMISTRY : THEORETICAL AND APPLIED. By Selected International Contributors. Collected and edited by Jerome Alexander. Volume IV. Second Series of Papers on Technical Applications. Pp. 734, 9×6. (New York : The Chemical Catalog Company, Inc., 1932.) Price $11.50.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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TEA FROM NYASALAND—II

IN a previous number of this BULLETIN (1931, **29**, 271) a report was published on three samples of tea produced in Nyasaland. They proved to be of promising quality and suggestions were made that other samples should be submitted for investigation.

Ten further samples were forwarded by the Director of Agriculture in March, 1932, with a view to investigating the effects of differences in manufacture, such as times and pressures of rolling and periods of fermentation, on the quality and value of the tea. They consisted of three series derived from three different estates, distinguished respectively as A, B and C, and had all been manufactured during the wet weather period.

DESCRIPTION

The samples, each weighing about 1 lb., consisted of manufactured black tea in good condition. They were labelled as follows :

Series A (seven samples).—Indian O.P. ; Local O.P. ; Indian B.O.P. ; Local B.O.P. ; Local F.B.O.P. ; Local B.P. ; Local Pekoe.

Series B (two samples).—No. 1 ; No. 2.
Series C (one sample).

The following particulars were furnished regarding the preparation of the samples of each of the three series.

SERIES A.

Withering.—Average time 19 hours, natural withers, percentage of moisture 47 per cent., average temperatures of lofts are minimum 68 degrees, maximum 75 degrees.

Rolling.—*1st* roll, 30 minutes without pressure.

2nd roll, 30 minutes slight pressure, 10 minutes on and 5 minutes off.

3rd roll, 30 minutes half pressure, 10 minutes on and 5 minutes off.

4th, 5th and *6th* rolls, 20 minutes each hard pressure, 10 minutes on and 5 minutes off.

After each roll the leaf is taken from the roller and put through the roll breaker, separating the big leaf from the small, the latter going straight to fermenting room.

Time of fermentation.—The average time is 3½ hours from the time the leaf enters the first roll. With Indian jat a longer fermentation is required and the time is about 4 hours.

Firing.—Firing temperature 210 degrees; time 12–14 minutes.

SERIES B.

Sample No. 1.

Withering.—Under favourable conditions leaf is spread at 1 lb. per sq. yard; more or less according to the amount of leaf to be spread. Withering takes place for 18–24 hours according to weather. With abnormal quantities of leaf the time allowed for withering must of necessity be cut down to make room for the following day's leaf. It must be said that withering space is not adequate, and the wither obtained is not so good as at the factory where sample No. 2 was made.

Rolling.—A normal rolling programme is as follows:
30 minutes, no pressure.
30 minutes, light pressure.
30 minutes, medium pressure, 10 minutes on, 5 off.
30 minutes, medium pressure, 10 minutes on, 5 off.
30 minutes, hard pressure, 10 minutes on, 5 off.

When large quantities of leaf have to be dealt with the following is the rolling programme :

30 minutes, no pressure.
30 minutes, slight pressure.
30 minutes, medium pressure, 10 minutes on, 5 off.
30 minutes, full pressure, 10 minutes on, 5 off.

This sample was made during a busy spell and the amount of rolling was considerably less than for sample No. 2.

Fermentation.—Judged by smell and colour ; average, fine bulk, 3 to 3½ hours ; coarse bulk, 4 hours ; counting from time leaf first put into rollers.

Sample No. 2.

Withering.—18 to 24 hours according to weather. Leaf is spread not more than 1 lb. to the square yard. There is ample withering space in this factory.

Rolling.—
40 minutes, no pressure.
30 minutes, pressure cap touching leaf.
30 minutes, half pressure.
30 minutes, full pressure, 5 minutes on, 10 off.
30 minutes, full pressure, 5 minutes on, 10 off.
30 minutes, full pressure, 5 minutes on, 10 off.

Fermentation.—Fine bulk, 3 to 3½ hours ; coarse bulk, 4½ hours ; counting from time leaf put into rollers.

The principal differences between the methods of manufacture of these two samples are that No. 2 is better withered, rolled longer and fermented slightly longer.

SERIES C.

Tea made between the 1/15th March, 1932.
Leaf 6/7 days' growth ; local jat.
Wither, 18/24 hours.
Rolling.—4 rolls,
1*st* roll, 30 minutes, no pressure.
2*nd* roll, 20 minutes, light pressure.
3*rd* roll, 20 minutes, 5 minutes heavy pressure, 5 minutes off.
4*th* roll, 20 minutes, same as No. 3.

Ball breaking, 10 minutes between each roll.
Fermentation, $3\frac{1}{2}$ hours to $3\frac{3}{4}$ hours on cement floor.
Drying in two operations, 1st drying at 210 degrees; 2nd drying at 200 degrees.

Results of Examination

The teas were examined with the results shown on next page, which are compared with the range of figures furnished by the previous samples from Nyasaland.

The results show that on the whole the teas are of satisfactory composition, resembling in this respect the black teas of India and Ceylon, which usually contain about 3 to 4 per cent. of caffeine and 13 to 15 per cent. of tannin. Of the present samples the following contain rather less tannin than the lower figure mentioned: Series A: Local O.P.; Series B: Nos. 1 and 2; and the single sample of Series C.

Commercial Value

The teas were submitted to (*a*) brokers and (*b*) merchants in London.

(*a*) The brokers furnished the following report:

Series A.

Indian O.P.—Blackish, fairly well twisted leaf. Liquor is light, plain. Infused leaf, rather mixed and greenish. Value $7\frac{1}{2}$*d.* per lb.

Local O.P.—Rather better style than the Indian O.P., one or two tips. Liquor is light, a little strength. Infused leaf, a few leaves have fair colour. Value $7\frac{3}{4}$*d.*–8*d.* per lb.

Indian B.O.P.—Black even leaf, plain in appearance. Liquor has fair colour and strength, plain. Infused leaf, rather mixed and greenish. Value 6*d.* per lb.

Local B.O.P.—Similar sized leaf to the Indian B.O.P., with a little tip. Liquor has better colour, a little quality. Infused leaf, fairly even, a few leaves having fair colour. Value $6\frac{1}{2}$*d.* per lb.

Local F.B.O.P.—Blackish, rather leafy, broken, of attractive appearance, with a fair show of bright tip.

—	Present Samples.										Previous Samples from Nyasaland.
	Series A.							Series B.		Series C.	
	Indian O.P.	Local O.P.	Indian B.O.P.	Local B.O.P.	Local F.B.O.P.	Local B.P.	Local Pekoe.	No. 1.	No. 2.	—	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9·3	9·2	8·5	8·5	8·5	8·5	8·3	8·4	8·3	9·4	7·4–7·9
Expressed on the moisture-free tea:											
Caffeine	4·02	3·32	4·24	4·44	4·19	3·39	3·85	3·71	3·18	3·57	3·99–4·53
Tannin	13·3	11·2	14·9	14·5	13·5	12·8	13·3	11·6	11·1	12·3	12·8–15·7
Hot-water Extract[1]	49·2	48·0	50·1	48·5	49·6	47·7	47·2	47·1	46·1	46·1	49·0–51·9
Total Mineral Matter	6·00	6·26	5·94	5·32	5·45	5·62	5·44	5·59	5·69	5·72	5·15–5·39
Ash, soluble in water	4·29	4·67	4·14	3·71	3·74	3·78	3·59	3·70	3·61	3·82	3·56–3·81
Ash, insoluble in water (less silica)	1·54	1·42	1·54	1·40	1·47	1·67	1·65	1·63	1·74	1·60	1·32–1·56
Silica	0·17	0·17	0·26	0·21	0·24	0·17	0·20	0·26	0·34	0·30	0·03–0·26

[1] *By Tatlock and Thompson's method.*

Liquor has fairly useful colour and strength, a little quality. Infused leaf, a few leaves have fair colour. Value about 1*s*. 2*d*. per lb.

Local B.P.—Blackish even leaf. Liquor is light, plain. Infused leaf, a little mixed and greenish. Value 6*d*. per lb.

Local Pekoe.—Black, rather choppy leaf. Liquor is light, plain. Infused leaf, rather mixed and greenish. Value 5¾*d*. per lb.

Series B.

No. 1.—Very similar in style and appearance to Series A, Local B.P., but the liquor has rather better colour and the infused leaf is a little brighter. Value 6*d*.–6¼*d*. per lb.

No. 2.—Similar sized leaf to the above. Liquor has fair colour and strength, a little plain. Infused leaf, rather mixed and greenish. Value 6*d*.–6½*d*. per lb.

Series C.

Very similar in all respects to Series A, Local B.O.P. Value 6½*d*. per lb.

(*b*) The importers reported as follows :

The local teas in Series A are superior in manufacture and liquor to the Indian teas.

All samples, with the exception of two, show good withering and good fermentation, the two exceptions being the Indian B.O.P. and the Local Pekoe, both in Series A.

We should like to refer to the excellent leaf manufacture of both the O.P. samples and also of the Local F.B.O.P. This latter has exceptionally good coloured tip, good style, an ideal " coppery coloured " infusion, and a liquor free from coarseness. The two Orange Pekoes have very good, thin, wiry leaf, and although the Local O.P. has a slightly better infusion and liquor than the Indian one, the latter makes up the deficiency with a slightly better leaf.

The two samples of Series B and the one of Series C seem to have suffered with rain, or at any rate a dampness, during or after manufacture. The liquors of all three taste coarse and a little rainy, and it would appear that

they have been either manufactured during the rainy season, or else have suffered through storage in a damp climate. The Series C sample is the worst in this connection, No. 2 of Series B is next, and No. 1 of Series B is the best.

Before giving a detailed description and approximate valuation for each sample, we should like to draw particular attention to the following observations.

The feature of the present tea market in London is that the difference in value between common liquoring tea and good medium liquoring tea is very small. This is explained by the fact that the quantity of bright medium liquoring tea is far in excess of demand. The public are at present drinking the lowest price tea in increasing quantities, with the result that large supplies of other and better grades, although being exceptionally cheap by comparison, are nevertheless unwanted because of lack of public demand.

Series A.

Indian O.P.—Very good leaf, wiry, little tip, dullish infusion and liquor. Value 8*d.* per lb.

Local O.P.—Very wiry, good leaf, fair infusion and liquor, both of which are better than the Indian O.P. Value 8*d.* per lb.

Indian B.O.P.—Small even "chopped" leaf, poor green infusion indicating under-fermentation; thin yellow liquor. Value 6½*d.* per lb.

Local B.O.P.—Semi-broken tea leaf, very few tips, no style, even coloured infusion, plain coloury liquor. The tea has been better fermented than Indian B.O.P. above. Value 7*d.* per lb.

Local F.B.O.P.—Good golden tip, style, good infusion, coloury plain liquor, no flavour. Value 1*s.* 6*d.* per lb.

Local B.P.—Even leaf, fair colour infusion and liquor. This tea has been also better fermented than the Indian B.O.P. Value 6¾*d.* per lb.

Local Pekoe.—Small even leaf, dull green infusion indicating underfermentation; thin liquor. Value 6*d.* per lb.

Series B.

No. 1.—Even broken Pekoe leaf, no tip, fair colour, good infusion, but the liquor is a little coarse and rainy. Value 6*d.* per lb.

No. 2.—Same description of leaf as above but the liquor and infusion are a little duller and coarser ; more rainy. Value 5¼*d.* per lb.

Series C.

Even semi-broken tea leaf with some tip ; a dull infusion, coarse, very rainy liquor. Value 6½*d.* per lb.

The comparatively high value of Series C sample compared with the two samples of Series B is solely due to the presence of tip in the leaf.

The Technical Adviser to this firm kindly added the following observations :

There is very little I can add to what has already been said by the Tea Department. Practically all the samples submitted show careful manufacture, and I should say that having regard to the elevation, climate and conditions under which the teas were manufactured, they are almost as good as one could reasonably expect.

Series A.

Withering.—In our practice it is usual to aim for a moisture content of withered leaf of from 55 to 60 per cent.

Rolling.—We have now instituted the following rolling programme :

30 minutes, no pressure.
30 minutes, medium pressure.
30 minutes, hard pressure, 3 minutes on, 3 off.
30 minutes, hard pressure, 3 minutes on, 3 off.
30 minutes, hard pressure, 3 minutes on, 3 off.

It has been found that short periods of pressure on and off allow the tea to be more evenly rolled as the more rapid changing of the conditions causes the leaf to be more evenly mixed.

Fermentation.—Three-and-a-half hours is average, but of course, no hard-and-fast rule can be laid down and it is largely a matter of judgment by smell and sight.

Firing.—Providing the moisture content of the leaf is as recommended above, we prefer a temperature of 180 degrees.

Series B.

The same remarks as regards manufacture apply as in Series A, but from my tasting of these two samples, I should judge that the "rainyness" noticed by the Tea Department was probably due to the jat of leaf. It would almost seem as though the teas were made from a hybrid China jat such as is found in Darjeeling, Terai and on some of the older estates in Southern India.

The fact that sample No. 2 is distinctly coarser and inferior to sample No. 1 is possibly due to over-rolling. This tends to produce dullness and coarseness in liquor, because although the teas may look perfectly manufactured when they leave the factory, a certain amount of maturing takes place afterwards, and it is better if teas are left a little green when they leave the factory; i.e. slight under-rolling and slight under-fermentation is preferable to the reverse.

TUNG SEED AND OIL FROM EMPIRE SOURCES

In this Bulletin (1932, **30**, 24) an account was given of the present position of the experimental cultivation of tung trees in the Empire. Samples of the fruit, seeds or oil produced in the course of some of these experiments have been received at the Imperial Institute for examination and in the following pages reports will be found on samples of *Aleurites Fordii* products from Assam and Dehra Dun in India, from New South Wales, the Transvaal, Natal and Nyasaland, and of *Aleurites montana* seeds from Ceylon. With the exception of the *A. Fordii* seeds from Natal, all the material was submitted for examination to

Dr. L. A. Jordan, Director of the Research Association of British Paint, Colour and Varnish Manufacturers and a member of the Imperial Institute Sub-Committee on Tung Oil, in accordance with an arrangement whereby the Association is carrying out, on behalf of the Sub-Committee, comparative investigations of tung seeds and oil from different sources.

A report on *Aleurites Fordii* fruits and seeds from Kenya Colony previously examined in the laboratories of the Imperial Institute was published in this BULLETIN (1929, **27**, 10).

For comparison with the materials received from Empire sources the results of examination of a sample of *Aleurites montana* fruits from China are included in the present article. Reference may also be made in this connection to an earlier report on samples of *A. Fordii* and *A. montana* seeds from China (this BULLETIN, 1930, **28**, 267).

TUNG OIL (*ALEURITES FORDII*) FROM ASSAM

This sample was expressed from nuts from young trees of *Aleurites Fordii* grown in Assam by Mr. D. S. Withers (see this BULLETIN, 1932, **30**, 29). The oil had been prepared by Messrs. The Gourepore Co., Ltd., Calcutta, who stated that the seed as received consisted of 60·3 per cent. of kernel and 39·7 per cent. of shell. The former contained 52·1 per cent. of oil (by weight), that is 31·4 per cent. on the whole seeds. Another sample of seeds contained 58 per cent. of kernels.

The following report was furnished by Dr. Jordan on the results of his investigation :

Colour	Straw
Acid value [1]	0·49
Iodine value (Wijs) [1]	168·6
Heat test [1]	11·8
Refractive index at 25° C.	1·5177
Density at 25° C.	0·9333

[1] *By method prescribed in British Standards Institution specification.*

"Details of the yields obtained from the fruit were given by the Gourepore Co. and there is no cause for comment on these figures, having regard to all the circumstances.

"The sample of oil was noteworthy for its exceedingly pale colour, and the chemical properties put it on a level with, or possibly even slightly above, that of the American *Aleurites Fordii* which we have regarded hitherto as our standard sample. Our general impression is that there is no need to fear the result if the quality of this oil can be maintained."

Aleurites Fordii Seeds from Dehra Dun, India

The sample of tung seed which is the subject of this report was forwarded to the Director, Royal Botanic Gardens, Kew, at the instance of the President of the Forest Research Institute and College, Dehra Dun, by the Officiating Forest Botanist, who stated that the tree is grown there to a very small extent and that he was given to understand that the Dehra Dun seed is conspicuously deficient in oil and of low quality. The seed was collected in 1930 from three different places where the tree is cultivated. No details could be supplied as to the age of the trees.

Dr. Jordan furnished the following report on the sample:

"*Condition of Sample.*—The sample consisted of kernel with shell complete. Exterior good but many seeds were empty.

Composition of Seeds

Average weight of seeds (kernel + shell) .	*grams*	1·6
Seeds consist of:		
Shell	*per cent.*	54·76
Kernel	,,	45·24
Moisture in kernel	,,	5·0
Oil in kernel (by petroleum ether) . .	,,	49·03
Oil in moisture-free kernel	,,	51·6
Oil in seeds as received	,,	22·2

EXAMINATION OF OIL

	Solvent extracted.	Cold pressed.
Colour	Pale	Pale
Acid value (mgm. KOH)[1] . .	1·06	1·0
Refractive index (25° C.) . .	1·5125	1·5203
Heat test[1]	10	9·5
Iodine value (Wijs)[1] . .	162·4	164·7

[1] *By method prescribed in British Standards Institution specification.*

"*Observations.*—The general observations are that the oil is well up to standard, and is equal to the best American tung oil in every respect but that of acid value and possibly colour. Both of these factors could be improved by careful control of the water content of the seed (by adequate drying before shipment). The only respect in which the seeds were found to be abnormal was in the oil content and this must be ascribed to the large number of empty seeds which were found."

Aleurites Fordii Fruits from New South Wales

This sample was sent by the Director of the Sydney Botanic Gardens and consisted of fruits of *Aleurites Fordii* grown by Mr. Rawes Whittell, Pennant Hills, New South Wales.

The following report on the material was furnished by Dr. Jordan:

"The sample was in very bad condition, and was extensively moulded. Thirty-two whole fruits and a quantity of broken material were present, total weight 790 gms. The thirty-two whole fruits weighed 532 gms. (average weight 16·6 gm.) and yielded an average of 4·44 seeds per fruit. In all 183 seeds were obtained of which only 120 proved to be sound. The average weight of the sound seeds was 2·1 gms. The kernels were separated and divided into two portions :

(*a*) Creamy white and normal,
(*b*) A dark brown translucent material.

"The occurrence of these two types of kernel is probably due to some change in (*b*) in transit. They were

investigated separately and will be referred to as (*a*) and (*b*) respectively."

COMPOSITION OF FRUIT

		New South Wales.		Chinese.[1]
Average weight of whole fruit	*grams*	16·6		—
Average number of seeds per fruit (kernel with inner shell)		4·44		—
Average weight of seed	*grams*	2·10		2·3
Whole fruit consists of:				
Husks	*per cent.*	55·2		—
Seeds	,,	44·8		—
Seed consists of:				
Shell	,,	42·7		46·0
Kernel	,,	57·3		54·0
Moisture	,,	6·2	(*a*)	4·5
Oil (by solvent extraction)	,,	56·8	(*a*)	55·9
		57·5	(*b*)	
Oil on dry decorticated kernel	,,	60·55	(*a*)	58·5
		—	(*b*)	
Oil on whole fruit	,,	14·58		—

[1] *This* BULLETIN (1930, **28**, 267).

EXAMINATION OF OIL

—	New South Wales. (*a*)	New South Wales. (*b*)	Chinese Solvent Extracted.	American Solvent Extracted.	American Tung Oil Corporation, 1929 Crop.
Specific gravity at 25° C.	0·937	—	—	—	—
Acid value (mgm. KOH)	0·84	1·26	11·55	0·65	0·88
Refractive index at 25° C.	1·5145	1·5150	1·5178	1·5182	—
Heat test[1]	12½	12½	10½	9	10
Iodine value (Wijs)[1]	169·9	168·3	170·2	164·4	165·2

[1] *By method prescribed in British Standards Institution specification.*

The above figures indicate that the oil from these Australian-grown fruits is in general of very similar composition to that of oil of Chinese and American origin. There is every reason to suppose that oils of these qualities would be merchantable in spite of the fact that they fail to pass the tests of the British Standards Institution with regard to refractive index (1·518 — 1·522 at 20° C. = 1·516 — 1·520 at 25° C.) and heat test (max. 12 mins.).

Insufficient oil was obtained to carry out any tests of a practical nature, but there is no obvious reason why the oil should not prove perfectly satisfactory for the preparation of the usual tung oil products.

Aleurites Fordii Fruits from the Transvaal

This sample was forwarded to the Director, Royal Botanic Gardens, Kew, by the Principal Botanist, Division of Plant Industry, Pretoria. The fruits were grown by Messrs. Banger and Allen, P.O. Bushbuck Ridge, via Pilgrims Rest, Transvaal, and were derived from the same tree as a previous sample examined in 1930. It was stated that this tree, obtained as a seedling from the Division of Plant Industry, Pretoria, is planted by itself and in June 1930 was about 5 years old and about 7 feet high.

Dr. Jordan's report on the fruits is given below.

Results of Examination

The sample was examined with the following results which are shown in comparison with the figures obtained for the fruits reported on in 1930 :

Composition of Fruit

		1931 Sample.	1930 Sample.
Average weight of fruit . .	*grams*	36·73	30·7
Average number of seeds per fruit		4·42	2·6
Average weight of seed . .	*grams*	4·59	4·55
Whole fruit consists of :			
Husk	*per cent.*	44·2	58·1
Seeds	,,	55·8	41·9
Seeds consist of :			
Shell	,,	34·9	45·4
Kernel	,,	65·1	54·6
Oil content of kernel . .	,,	60·25	51·5
Oil content of whole fruit . .	,,	21·9	11·8

Examination of Oil

	1931 Sample.	1930 Sample.
Refractive index of oil (25° C.) . .	1·5189	1·5151
Acid value (mgm. KOH) . . .	2·32	0·26
Heat test[1]	10·5	13·25
Iodine value (Wijs)[1]	173·2	163·7

[1] *By method prescribed in British Standards Institution specification.*

It will be seen from the results of the examination that the present sample contains a normal number of seeds per fruit and in this respect differs considerably from the

previous one. The percentage of kernel in the seeds received in 1931 and of oil in the kernels are higher than those for the 1930 sample. These differences account for the oil content of the present fruits being nearly double that of the previous sample. It would therefore appear that the small number of seeds in the fruits examined in 1930 was due to their being the first fruits of the tree.

The results indicate that the oil from the present sample of fruits is of better quality than the earlier one and that it fulfils the requirements of the British Standards Institution specification.

Conclusions

The fruits in the present sample are of normal character, containing the usual number of seeds per fruit and yielding as much oil as those grown in Florida (20·0 — 21·5 per cent.). The oil is of satisfactory quality, being of very similar composition to tung oil of Chinese and American origin, and satisfying the tests of the British Standards Institution. Consignments of similar oil would be readily saleable in the United Kingdom and other countries.

Aleurites Fordii Seeds from Natal

The sample of tung seeds (*Aleurites Fordii*) which is the subject of this report was forwarded to the Imperial Institute by the Department of Overseas Trade at the suggestion of H.M. Trade Commissioner at Durban.

The seeds were stated to have been grown by Mr. J. Hunt-Holley of Wartburg, near Pietermaritzburg, who is carrying out experiments with tung oil trees.

The sample was examined at the Imperial Institute with the following results:

It weighed 2 oz. and consisted of tung seeds of normal appearance, averaging 4·2 grams in weight. The seeds consisted of kernel, 64·1 per cent., and shell, 35·9 per cent.; all the seeds contained well developed kernels.

On treatment with light petroleum the kernels were found to contain 60·5 per cent. of oil, which was of pale yellow colour and had the usual appearance of tung oil. The oil had the following constants:

Refractive index at 20° C. . . .	1·5193
Iodine value (Wijs, 1 hour)[1] . . .	166·1
Heat test[1]	11¾ minutes.

[1] *By method prescribed in British Standards Institution specification.*

The foregoing results show that this sample of tung seeds contained a high percentage of kernels. The percentage of oil in the kernels was also high, being slightly above the normal for the kernels of Chinese seeds.

The oil was of good colour and satisfactory quality. Owing to the small quantity of oil available only a partial examination could be made, but the results showed that in respect of refractive index, iodine value and behaviour on heating it would satisfy the requirements of the standard specification for tung oil of the British Standards Institution.

The seeds were therefore of very good quality.

Aleurites Fordii Fruits from Nyasaland

The sample of tung fruits which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture in April, 1932. The fruits were stated to have been collected by the Conservator of Forests from tung trees (*A. Fordii*) growing in the Kanjedza Forest Reserve, Limbe. The original seed had been supplied by Kew in 1928 and the nursery plants put out the field in January 1929.

The following report on the fruits was furnished by Dr. Jordan:

"The sample as received consisted of complete fruits in an entirely dry and satisfactory condition. Their composition was if anything superior to the average of the species.

"The oil expressed from the seed is of outstanding quality as regards colour and acid value, while its chemical characteristics are in accord with those usually recorded for the species. On test, the oil is found to dry in a normal manner yielding a satisfactory film and would appear to be suitable for incorporation in varnish, etc. The sample was too small for extended tests of a practical character."

EXAMINATION OF FRUIT

Average weight of whole fruit	*grams*	24·0
Average number of seeds per fruit		4·4
Average weight of seed	*grams*	3·08
Whole fruit consists of :		
Husk	*per cent.*	42·9
Seeds	,,	57·1
Seeds consist of :		
Shell	,,	42·4
Kernel	,,	57·6
Kernel contains :		
Moisture	,,	5·3
Oil	,,	49·8
Oil content of dry kernel	,,	52·6
Oil content of whole fruit	,,	16·4

EXAMINATION OF OIL

Oil expressed cold by laboratory press from completely decorticated seed.

Colour (Lovibond, in 25 mm. cell)	Red, 0·70	Yellow, 3·8
Density at 25°		0·9363
Refractive index at 25° (D line)		1·5192
Acid value		0·3
Iodine value		166·3
Heat test (Browne)		11·6 mins.

"The gel given in the heat test was entirely satisfactory."

Aleurites montana Seed from Ceylon

A sample of *Aleurites montana* seed was forwarded to the Imperial Institute by the Director of Agriculture in January, 1932. The seed was stated to have been obtained from known trees grown at Peradeniya which are just beginning to bear.

The following report was furnished by Dr. Jordan on the results of the investigation:

COMPOSITION OF SEEDS

Average weight of seeds	*grams*	2·79
The seeds consist of :		
Shell	*per cent.*	43·8
Kernel	,,	56·2
The kernels contain :		
Moisture	,,	4·91
Oil (by solvent extraction)	,,	47·3
Oil on dry kernel	,,	49·75
Oil on seeds	,,	26·59

EXAMINATION OF OIL

Solvent extraction .	On 300 grams meal from decorticated seeds.
Method . . .	Petrol ether (60–80° C.).
Pressed . . .	300 grams meal from decorticated seeds.
Method . . .	Pressed cold.

	Solvent Extraction.	Pressed Oil.
Colour	Yellow	Yellow
Acid value[1]	0·434	0·406
Iodine value (Wijs)[1] . .	163·0	163·3
Heat test[1]	14·6	14·9
Refractive index 25° C. . .	1·5142	1·5140
Density 25° C.	0·9311	0·9311

[1] *By method prescribed in British Standards Institution specification.*

Remarks

"The sample consisted of seeds in good condition. The oil was obtained both by cold pressing and by solvent extraction ; the solvent used was petrol ether, range 60–80° C. The oil had the usual straw yellow colour, rather on the pale side, and possessed a desirably low acid value.

"This Ceylon *montana* oil is on the general *montana* level.

"Although the present standard specifications make no provision for *montana* oils as such, and in consequence of which they sometimes fall outside tung oil specification range in certain respects, nevertheless oil of this quality would be quite saleable and valuable for varnish making on the British market at this moment.

"It is as well to point out, however, that there will be an increasing tendency sooner or later to discriminate between these different classes of oils and *montana* may sometimes be forced to a discount as compared with *Fordii* oils."

ALEURITES MONTANA FRUITS FROM CHINA

The sample of *Aleurites montana* fruits which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture, Peradeniya, Ceylon, in February, 1932. The fruits were stated to have been obtained from China.

The following report was furnished by Dr. Jordan on the results of the investigation:

"The sample consists of segments of fruit, in fair but slightly damp condition. The composition, as shown in the tables below, closely resembles an average value for the species, and it may be taken as representative of the Chinese product.

"The oil expressed from the decorticated seed is a characteristic *A. montana* oil, but is remarkable in its colour and acid value: these both approach those of commercial Chinese oils, though laboratory pressed oils are usually considerably lower. This may be due to the fruits having been packed in a somewhat damp condition.

"The oil shows a low refractive index and lengthened heat test, both of which are characteristics of the *montana* species. It also shows admirable drying properties, and may be regarded as entirely promising as a varnish oil."

Examination of Fruit

Average weight of seed	*grams*	3·31
Whole fruit consists of:		
Husk	*per cent.*	51·5
Seeds	,,	48·5
Seeds consist of:		
Shell	,,	44·0
Kernel	,,	56·0
Kernel contains:		
Moisture	,,	10·3
Oil	,,	59·1
Oil content of whole fruit	,,	17·0

Examination of Oil

Oil expressed in the cold by laboratory hydraulic press from completely decorticated seed.

Colour (Lovibond in 25 mm. cell)	Red, 1·5	Yellow, 50
Density at 25° C.		0·9314
Refractive index at 25° C.		1·5140
Acid value		3·2
Iodine value		162·2
Heat test (Browne)		17·3 mins.

"The gel given in the heat test was of satisfactory quality."

"There is every reason to suppose that the varnish produced is satisfactory, but the trials take a long time and the durability tests are not yet complete (August, 1932)."

SHEA NUTS FROM THE GOLD COAST

IN connection with the investigation which is being carried out at the Imperial Institute into the yield and quality of the fat of different varieties of West African shea nuts, two series of nuts from Nigeria have already been dealt with in this BULLETIN (1930, **28**, 123; 1931, **29**, 407). Early this year twenty-three samples from the Gold Coast were received for examination. They had been collected at Yendi Shea Reserve from marked trees which had been chosen to represent as great a range of variation as possible, especially in respect of bark formation and leaf shape.

The following brief descriptions of the trees were supplied by the Economic Botanist:

Tree 5. Medium sized tree. Very crinkled bark. Fruits set before leaves formed.

Tree 6. Small tree. New leaves formed before fruits set.

Tree 8. Medium sized tree. Little branching. Fruits set before new leaves formed.

Tree 9. Medium sized tree. Very crinkled bark. Large leaves. New leaves formed before fruits set.

Tree 10. Medium sized tree. Very large leaves. Good crop. Fruits set before new leaves formed.

Tree 11. Large tree. Typical bark. Large amount of fruits set before new leaves formed.

Tree 12. Medium tall tree. Bark rough and not typical. New leaves formed before fruits set.

Tree 13. Medium sized tree. Fruits set before new leaves formed. Bark with large squares. Medium number of fruits set. One flower noted with 7 stamens.

Tree 15. Medium size: coarse and irregular bark. Leaves medium size. Very narrow. New leaves formed before fruits set.

Tree 16. Medium size. Large leaves. Fruits set before new leaves formed.

Tree P. 1. Small tree. Produces a large number of buds, but few fruits.

Tree P. 2. Rather larger than P. 1. Set a fair number of fruits. Fruits set before new leaves formed.

Tree P. 3. Small tree. Produced large number of flowers. Fruits set before new leaves formed.

Tree P. 4. Small tree. Set a very heavy crop. Fruits set before new leaves formed.

Tree P. 5. Small tree. Medium number of fruits set.

Tree P. 6. Medium sized tree. New leaves appearing as fruits set. Large number of fruits set.

Tree D. Tall tree with little branching: normal bark. New leaves well developed before fruits set. Few fruits set. Very large leaves.

Tree D. 2. Medium sized tree. Late and heavy flowering before fruits set.

Tree E. Medium tall tree. Fruits set before new leaves formed. Fair number of flowers.

Tree R. Tall tree. Very crinkled bark. Fruits set before new leaves formed. Medium number of fruits set.

Tree X. 3. Large tree.

Tree X. 37. Large tree. New leaves appearing as fruits set.

Tree X. 66. Medium sized tree.

Description

The general characters of the samples are recorded in the tables on pages 284–287.

Label.	Weight.	Description of Nuts.	Colour of Nuts.	Dimensions of Nuts.	Internal Colour of Kernels.	Dimensions of Kernels.
	lb.			*inches.*		*inches.*
T5	1	Small to medium. Mostly blunt; some somewhat pointed. Some insect attack.	Yellowish-brown to dark brown; mostly golden-brown.	0·9 × 0·7 to 1·2 × 1·0. Mostly 1·0 × 0·9.	Buff to purplish-red; mostly pale pinkish-brown. Some covered with mould.	0·8 × 0·5 to 1·0 × 0·7. Mostly 0·9 × 0·6.
T6	1	Small to medium. Mostly rather pointed. Some insect attack.	Pale yellowish-brown to dark brown; mostly golden-brown.	0·8 × 0·6 to 1·2 × 0·9. Mostly 1·0 × 0·8.	Buff to dark pinkish-brown; mostly buff. Some covered with mould.	0·7 × 0·5 to 1·0 × 0·7. Mostly 0·8 × 0·6.
T8	3	Very small to medium; mostly small. Mostly rather pointed. Some insect attack.	Pale yellowish-brown to dark brown; mostly light golden-brown and golden-brown in equal proportions.	0·75 × 0·6 to 1·1 × 1·0. Mostly 1·0 × 0·8.	Buff to dark chocolate; mostly pinkish-brown. Some covered with mould.	0·6 × 0·5 to 1·0 × 0·7. Mostly 0·8 × 0·6.
T9	$1\frac{1}{4}$	Small to large. Some pointed; some blunt. Some insect attack.	Yellowish-brown to dark brown; mostly golden-brown.	0·8 × 0·6 to 1·4 × 1·0. Mostly 1·0 × 0·8.	Creamy brown to chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·6 × 0·4 to 1·2 × 0·7. Mostly 0·8 × 0·7.
T10	6	Very small to medium. Mostly rather pointed. Slight insect attack.	Yellowish-brown to dark reddish-brown; mostly golden-brown.	0·8 × 0·6 to 1·2 × 0·9. Mostly 1·0 × 0·8.	Pale buff to dark chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·7 × 0·5 to 1·1 × 0·7. Mostly 0·8 × 0·6.
T11	$4\frac{1}{2}$	Very small to medium. Some rather pointed, others blunt. Some insect attack.	Yellowish-brown to reddish-brown; mostly golden-brown.	0·8 × 0·6 to 1·3 × 1·0. Mostly 1·0 × 0·8.	Pale buff to chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·7 × 0·5 to 1·1 × 0·7. Mostly 0·9 × 0·6.

T12	1¼	Small to medium. Mostly pointed. Some insect attack.	Dull and dirty. Light golden-brown and dark brown in about equal proportions.	0·8 × 0·6 to 1·2 × 1·0. Mostly 1·0 × 0·7.	Buff to dark chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·7 × 0·5 to 1·0 × 0·7. Mostly 0·9 × 0·6.
T13	2½	Small to medium. Mostly pointed. Slight insect attack.	Dull. Golden-brown to dark brown; mostly brown.	0·9 × 0·7 to 1·2 × 1·0. Mostly 1·1 × 0·9.	Pale pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·8 × 0·6 to 1·0 × 0·8. Mostly 0·9 × 0·7.
T15	1¼	Small to medium. Some somewhat pointed; some blunt. Slight insect attack.	Light golden-brown to dark brown; mostly golden-brown.	0·9 × 0·6 to 1·1 × 0·9. Mostly 1·0 × 0·8.	Pale pinkish-brown to chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·7 × 0·4 to 1·0 × 0·7. Mostly 0·9 × 0·6.
T16	1¼	Small to medium; mostly medium. Mostly somewhat pointed; some blunt. Some insect attack.	Light golden-brown to dark brown; mostly golden-brown.	0·9 × 0·8 to 1·3 × 1·0. Mostly 1·1 × 0·9.	Light pinkish-brown to chocolate-brown; mostly light pinkish-brown or pinkish-brown. Many covered with mould.	0·7 × 0·6 to 1·0 × 0·8. Mostly 0·9 × 0·7.
P1	5½	Small to medium. Mostly somewhat pointed. Some insect attack.	Golden-brown to dark brown; mostly golden-brown.	0·8 × 0·7 to 1·1 × 0·9. Mostly 0·9 × 0·8.	Pale pinkish-brown to dark chocolate; mostly pinkish-brown. Some covered with mould.	0·6 × 0·5 to 0·9 × 0·7. Mostly 0·8 × 0·6.
P2	7	Very small to medium. Mostly pointed. Some insect attack.	Yellowish-brown to dark brown, mostly golden-brown.	0·8 × 0·5 to 1·2 × 1·0. Mostly 1·0 × 0·8.	Pale buff to dark chocolate; mostly pinkish-brown or pale buff. Some covered with mould.	0·7 × 0·4 to 1·0 × 0·8. Mostly 0·8 × 0·6.

Label.	Weight.	Description of Nuts.	Colour of Nuts.	Dimensions of Nuts.	Internal Colour of Kernels.	Dimensions of Kernels.
	lb.			*inches.*		*inches.*
P3	1	Medium to large. Some pointed. Mostly blunt. Practically free from insect attack.	Golden-brown to dark brown; mostly golden-brown.	1·0 × 0·8 to 1·3 × 1·0. Mostly 1·1 × 0·9.	Pale pinkish-brown to chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·8 × 0·6 to 1·1 × 0·7. Mostly 1·0 × 0·7.
P4	$\frac{3}{4}$	Mostly small. Mostly pointed. Slight insect attack.	Light golden-brown to dark brown; mostly golden-brown.	0·8 × 0·6 to 1·1 × 0·9. Mostly 1·0 × 0·8.	Creamy-brown to chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·7 × 0·5 to 0·9 × 0·7. Mostly 0·8 × 0·6.
P5	$1\frac{3}{4}$	Small to medium. Mostly blunt; some pointed. Slight insect attack.	Light golden-brown to golden-brown, some dark brown.	0·9 × 0·7 to 1·1 × 0·9. Mostly 1·0 × 0·8.	Light pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Many covered with mould.	0·7 × 0·6 to 0·9 × 0·8. Mostly 0·8 × 0·6.
P6	1	Small to medium. Some pointed; others blunt. Slight insect attack.	Golden-brown to dark chocolate-brown.	0·8 × 0·6 to 1·1 × 0·9. Mostly 1·0 × 0·7.	Light pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Mostly covered with mould.	0·7 × 0·5 to 1·0 × 0·7. Mostly 0·8 × 0·6.
D	1	Small; more uniform in size than any other sample. Pointed. Slight insect attack.	Light golden-brown to dark brown; mostly reddish-brown or dark brown.	0·9 × 0·6 to 1·1 × 0·9. Mostly 1·0 × 0·7.	Light pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Some covered with mould.	0·8 × 0·5 to 0·9 × 0·6. Mostly 0·8 × 0·6.

D2	1	Very small to small. Mostly pointed ; few blunt. Bad insect attack.	Light golden-brown to dark brown.	$0{\cdot}8 \times 0{\cdot}5$ to $1{\cdot}1 \times 0{\cdot}8$. Mostly $0{\cdot}9 \times 0{\cdot}7$.	Yellowish-brown to chocolate-brown ; mostly pinkish-brown. Many covered with mould.	$0{\cdot}7 \times 0{\cdot}4$ to $0{\cdot}9 \times 0{\cdot}6$. Mostly $0{\cdot}8 \times 0{\cdot}5$.
E	$2\frac{1}{4}$	Small to medium ; mostly medium. Mostly somewhat blunt; some pointed. Slight insect attack.	Light golden-brown to dark brown; mostly golden-brown.	$0{\cdot}8 \times 0{\cdot}6$ to $1{\cdot}3 \times 1{\cdot}0$. Mostly $1{\cdot}0 \times 0{\cdot}8$.	Light pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Many covered with mould.	$0{\cdot}6 \times 0{\cdot}4$ to $1{\cdot}1 \times 0{\cdot}8$. Mostly $0{\cdot}8 \times 0{\cdot}6$.
R	$5\frac{1}{2}$	Small to medium. Mostly blunt. Insect attacked.	Light golden-brown to dark brown ; on whole lighter in colour than X37.	$0{\cdot}7 \times 0{\cdot}5$ to $1{\cdot}1 \times 0{\cdot}9$. Mostly $0{\cdot}9 \times 0{\cdot}7$.	Pale pinkish-brown to dark chocolate-brown; mostly chocolate-brown. Many covered with mould.	$0{\cdot}6 \times 0{\cdot}4$ to $1{\cdot}0 \times 0{\cdot}7$. Mostly $0{\cdot}8 \times 0{\cdot}6$.
X3	$2\frac{1}{2}$	Medium. Pointed. Some insect attack.	Dull. Brown. Fairly uniform in colour and size.	$0{\cdot}9 \times 0{\cdot}7$ to $1{\cdot}3 \times 0{\cdot}9$. Mostly $1{\cdot}2 \times 0{\cdot}8$.	Pale pinkish-brown to almost black ; mostly pinkish-brown. Many covered with mould.	$0{\cdot}8 \times 0{\cdot}6$ to $1{\cdot}0 \times 0{\cdot}7$. Mostly $0{\cdot}9 \times 0{\cdot}6$.
X37	$3\frac{3}{4}$	Small to medium. Blunt. Bad insect attack.	Golden-brown to dark brown.	$0{\cdot}9 \times 0{\cdot}7$ to $1{\cdot}2 \times 1{\cdot}0$. Mostly $1{\cdot}0 \times 0{\cdot}8$.	Pinkish-brown to dark chocolate-brown ; mostly chocolate-brown. Few covered with mould.	$0{\cdot}6 \times 0{\cdot}5$ to $1{\cdot}0 \times 0{\cdot}7$. Mostly $0{\cdot}8 \times 0{\cdot}6$.
X66	1	Small to medium ; mostly medium. Mostly very blunt. Some insect attack.	Golden-brown.	$0{\cdot}8 \times 0{\cdot}7$ to $1{\cdot}1 \times 1{\cdot}0$. Mostly $1{\cdot}0 \times 0{\cdot}9$.	Light pinkish-brown to dark chocolate-brown; mostly pinkish-brown. Some covered with mould.	$0{\cdot}7 \times 0{\cdot}5$ to $1{\cdot}0 \times 0{\cdot}8$. Mostly $0{\cdot}9 \times 0{\cdot}7$.

TABLE I

Sample.	T5.	T6.	T8.	T9	T10.	T11.	T12.	T13.	T15.	T16.	P1.	P2.	P3.	P4.	P5.	P6.	D.	D2.	E.	R.	X3.	X37	X66.
Average weight of nuts *grams*	3·9	4·2	3·7	3·9	3·6	4·0	3·8	4·6	4·0	5·4	3·5	3·6	5·7	3·6	4·3	3·3	3·6	2·7	4·0	3·7	4·7	3·5	5·0
Average weight of kernels *grams*	2·5	3·0	2·6	2·7	2·5	2·7	2·6	3·2	2·8	3·7	2·3	2·5	4·1	2·4	3·0	2·2	2·5	1·8	2·8	2·5	3·1	2·4	3·7
Kernel in nuts . *per cent.*	65·0	71·0	69·3	67·5	68·3	67·3	67·5	70·0	69·5	69·0	66·0	68·3	71·0	67·0	70·0	67·0	67·5	67·5	70·3	68·8	66·3	69·0	73·5
Shell in nuts . *per cent.*	35·0	29·0	30·7	32·5	31·7	32·7	32·5	30·0	30·5	31·0	34·0	31·7	29·0	33·0	30·0	33·0	32·5	32·5	29·7	31·2	33·7	31·0	26·5
Moisture in kernels *per cent.*	7·3	6·0	5·9	6·3	5·9	6·5	5·9	6·0	6·1	6·2	5·7	6·2	6·0	5·4	6·1	6·6	6·3	5·6	6·3	6·4	5·8	7·1	6·1
Oil in kernels as received *per cent.*	38·8	48·4	48·4	46·9	48·3	44·0	49·1	51·5	49·2	48·1	52·8	47·6	49·1	51·7	50·0	50·1	48·9	51·0	47·8	47·9	49·3	43·6	49·7
Oil in moisture-free kernels *per cent.*	41·9	51·5	51·4	50·1	51·3	47·1	52·2	54·8	52·4	51·3	56·0	50·8	52·2	54·7	53·3	53·6	52·2	54·0	51·0	51·2	52·3	46·9	52·9
Oil in nuts . *per cent.*	25·2	34·4	33·5	31·7	33·0	29·6	33·1	36·0	34·2	33·2	34·8	32·5	34·9	34·6	33·0	33·6	33·0	34·4	33·6	33·0	32·7	30·1	36·5
Unsaponifiable matter in oil . . *per cent.*	8·9	6·0	4·9	5·9	5·1	5·5	5·3	6·0	4·7	4·4	4·9	5·3	6·4	4·1	4·1	5·2	7·3	5·3	5·4	4·8	5·6	4·3	3·5

Results of Examination

The samples were submitted to detailed examination and the results are recorded in Tables I to VI. Table I gives the results of determinations of the relative weights and composition of the nuts, the amounts of oil which they contain and the percentages of unsaponifiable matter in the oil. Tables II to VI show the correlation of the unsaponifiable matter with other factors.

TABLE II

Relation of percentage of kernels in nuts to percentage of oil (expressed on kernels as received and on moisture-free kernels) and to percentage of unsaponifiable matter in oil.

Sample.	Kernels in nuts.	Oil in kernels as received.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*	*Per cent*	*Per cent.*
X66	73·5	49·7	52·9	3·5
P3	71·0	49·1	52·2	6·4
T6	71·0	48·4	51·5	6·0
E	70·3	47·8	51·0	5·4
T13	70·0	51·5	54·8	6·0
P5	70·0	50·0	53·3	4·1
T15	69·5	49·2	52·4	4·7
T8	69·3	48·4	51·4	4·9
T16	69·0	48·1	51·3	4·4
X37	69·0	43·6	46·9	4·3
R	68·8	47·9	51·2	4·8
T10	68·3	48·3	51·3	5·1
P2	68·3	47·6	50·8	5·3
D2	67·5	51·0	54·0	5·3
T12	67·5	49·1	52·2	5·3
D	67·5	48·9	52·2	7·3
T9	67·5	46·9	50·1	5·9
T11	67·3	44·0	47·1	5·5
P4	67·0	51·7	54·7	4·1
P6	67·0	50·1	53·6	5·2
X3	66·3	49·3	52·3	5·6
P1	66·0	52·8	56·0	4·9
T5	65·0	38·8	41·9	8·9

TABLE III

Relation of percentage of oil in moisture-free kernels to percentage of unsaponifiable matter in oil.

Sample.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.	Sample.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
P1 . .	56·0	4·9	T6 . .	51·5	6·0
T13 . .	54·8	6·0	T8 . .	51·4	4·9
P4 . .	54·7	4·1	T16 . .	51·3	4·4
D2 . .	54·0	5·3	T10 . .	51·3	5·1
P6 . .	53·6	5·2	R . .	51·2	4·8
P5 . .	53·3	4·1	E . .	51·0	5·4
X66 . .	52·9	3·5	P2 . .	50·8	5·3
T15 . .	52·4	4·7	T9 . .	50·1	5·9
X3 . .	52·3	5·6	T11 . .	47·1	5·5
T12 . .	52·2	5·3	X37 . .	46·9	4·3
P3 . .	52·2	6·4	T5 . .	41·9	8·9
D . .	52·2	7·3			

TABLE IV

Relation of percentage of oil in entire nuts to percentage of unsaponifiable matter in oil.

Sample.	Oil in entire nuts.	Unsaponifiable matter in oil.	Sample.	Oil in entire nuts.	Unsaponifiable matter in oil.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
X66 . .	36·5	3·5	T16 . .	33·2	4·4
T13 . .	36·0	6·0	T12 . .	33·1	5·3
P5 . .	35·0	4·1	R . .	33·0	4·8
P3 . .	34·9	6·4	T10 . .	33·0	5·1
P1 . .	34·8	4·9	D . .	33·0	7·3
P4 . .	34·6	4·1	X3 . .	32·7	5·6
D2 . .	34·4	5·3	P2 . .	32·5	5·3
T6 . .	34·4	6·0	T9 . .	31·7	5·9
T15 . .	34·2	4·7	X37 . .	30·1	4·3
P6 . .	33·6	5·2	T11 . .	29·6	5·5
E . .	33·6	5·4	T5 . .	25·2	8·9
T8 . .	33·5	4·9			

TABLE V

Relation of average weight of kernel to percentage of unsaponifiable matter in oil.

Sample.	Average weight of kernel.	Unsaponifiable matter in oil.	Sample.	Average weight of kernel.	Unsaponifiable matter in oil.
	grams.	*Per cent.*		*grams.*	*Per cent.*
P3 . .	4·1	6·4	T12 . .	2·6	5·3
X66 . .	3·7	3·5	R . .	2·5	4·8
T16 . .	3·7	4·4	T10 . .	2·5	5·1
T13 . .	3·2	6·0	P2 . .	2·5	5·3
X3 . .	3·1	5·6	D . .	2·5	7·3
P5 . .	3·0	4·1	T5 . .	2·5	8·9
T6 . .	3·0	6·0	P4 . .	2·4	4·1
T15 . .	2·8	4·7	X37 . .	2·4	4·3
E . .	2·8	5·4	P1 . .	2·3	4·9
T11 . .	2·7	5·5	P6 . .	2·2	5·2
T9 . .	2·7	5·9	D2 . .	1·8	5·3
T8 . .	2·6	4·9			

TABLE VI

Average percentage of unsaponifiable matter expressed on kernels as received, on moisture-free kernels and on the whole nuts.

Sample.	Oil in kernels as received.	Oil in moisture-free kernels.	Unsaponifiable matter in oil.	Unsaponifiable matter in kernels as received.	Unsaponifiable matter in moisture-free kernels.	Unsaponifiable matter in nuts.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
P1	52·8	56·0	4·9	2·59	2·75	1·71
P4	51·7	54·7	4·1	2·12	2·24	1·42
T13	51·5	54·8	6·0	3·09	3·29	2·16
D2	51·0	54·0	5·3	2·70	2·86	1·82
P6	50·1	53·6	5·2	2·61	2·79	1·75
P5	50·0	53·3	4·1	2·05	2·19	1·44
Average (50 per cent. and over.)	51·2	54·4	4·9	2·53	2·69	1·72
X66	49·7	52·9	3·5	1·74	1·85	1·28
X3	49·3	52·3	5·6	2·76	2·93	1·83
T15	49·2	52·4	4·7	2·31	2·46	1·61
P3	49·1	52·2	6·4	3·14	3·34	2·23
T12	49·1	52·2	5·3	2·60	2·77	1·75
D	48·9	52·2	7·3	3·57	3·81	2·41
T6	48·4	51·5	6·0	2·90	3·09	2·07
T8	48·4	51·4	4·9	2·37	2·52	1·64
T10	48·3	51·3	5·1	2·46	2·62	1·68
T16	48·1	51·3	4·4	2·12	2·26	1·46
[illegible]	47·9	51·2	4·8	2·30	2·46	1·58
E	47·8	51·0	5·4	2·58	2·75	1·81
P2	47·6	50·8	5·3	2·52	2·69	1·72
T9	46·9	50·1	5·9	2·77	2·96	1·87
Average (45–49·9 per cent.)	48·5	51·6	5·3	2·58	2·75	1·78
T11	44·0	47·1	5·5	2·42	2·59	1·63
X37	43·6	46·9	4·3	1·88	2·02	1·29
Average (40–44·9 per cent.)	43·8	47·0	4·9	2·15	2·31	1·46
T5	38·8	41·9	8·9	3·45	3·73	2·24

Remarks

The following observations may be made upon the results of the examination of these 23 samples of shea nuts from Yendi:

(1) The percentage of kernels in the nuts varies from 65·0 to 73·5, with an average of 68·5. In 21 samples the range is narrower still, being from 66 to 71 per cent. (Tables I and II).

(2) The kernels, as received, contain from 38·8 to 52·8 per cent. of oil, with an average of 48·4. For 20 samples the oil content falls within a range of 6 per cent., viz. from 46·9 to 52·8 (Tables I and II).

(3) The oil content expressed on the moisture-free kernels varies from 41·9 to 56·0 per cent., with an average of 51·5. For 20 samples the figures range from 50·1 to 56·0 per cent. (Tables I and III).

(4) Sample P1 gives the highest percentage of oil from the kernels (both as received and moisture-free) and T5 the lowest.

The P samples are on the whole richer in oil than the T samples and the oils from them contain less unsaponifiable matter (Table I).

(5) There appears to be no relation between the percentage of kernels in the nuts and the percentage of oil in the kernels as received or in the moisture-free kernels (Table II).

(6) The percentage of unsaponifiable matter in the oil varies from 3·5 to 8·9, with an average of 5·3. For 19 samples the figures lie between 4 and 6 per cent.

The oil from T5 contains the largest proportion of unsaponifiable matter and that from X66 the least (Table I).

(7) There appears on the whole to be no relation between: (*a*) the percentage of kernels in the nuts and the percentage of unsaponifiable matter in the oil; and (*b*) the percentage of oil in the nuts and the percentage of unsaponifiable matter in the oil.

It will be noticed, however, that Sample X66, the oil of which contains the lowest percentage of unsaponifiable matter, furnishes the highest percentage of kernels and the highest percentage of oil in the nuts; whereas Sample T5, the oil of which contains the highest percentage of unsaponifiable matter, furnishes the lowest percentage of kernels and the lowest percentage of oil in the nuts (Tables II and IV).

(8) In Table VI the percentage of unsaponifiable matter in the oil is shown in comparison with the amount of oil in the kernels. The average results for the groups show a tendency for the samples yielding most oil from the kernels to contain a lower percentage of unsaponifiable matter in

the oil. The figures for each group, expressing the average percentage of unsaponifiable matter in the kernels as received, in the moisture-free kernels and in the whole nuts, are in close agreement.

(9) There appears to be no relation between the average weight of a kernel and the percentage of unsaponifiable matter in the oil (Table V).

(10) There is no relation between the colour or shape of the nuts and the percentages of unsaponifiable matter in the oil.

(11) *Comparison with the samples from Nigeria* (see this BULLETIN, 1930, **28**, 123; 1931, **29**, 407). On the whole, the Gold Coast samples are richer in oil and the oils contain less unsaponifiable matter than the Nigerian samples. The oil content of the Gold Coast kernels, as received, varies from 38·8 to 52·8 per cent., mainly from 46·9 to 52·8 per cent.; the corresponding figures for the Nigerian samples are from 27·0 to 47·6 per cent., mostly from 34·3 to 47·6 per cent. The unsaponifiable matter in the Gold Coast oils ranges from 3·5 to 8·9 per cent., with an average of 5·3; and in the Nigerian oils from 5·1 to 16·6 per cent., with an average of 8·8. It will be noticed that in both cases the Gold Coast results fall within much narrower limits than those for the Nigerian samples.

The results for the Gold Coast samples summarised in (8) above tend to support the provisional conclusion drawn from the results of the examination of the Nigerian sets, that the lower the oil-content of the kernels the higher the percentage of unsaponifiable matter in the oil.

DEER SKINS FROM NEW ZEALAND

FOR some years past efforts have been made in New Zealand to reduce the number of deer in the Dominion as it was found that the herds, which harbour in the forests, had so rapidly increased as to be a serious menace to the forest growth. In 1926 the rate of annual increase was estimated at probably over 25 per cent., and the yearly

damage was considered to be in the neighbourhood of £180,000.

According to the New Zealand Official Yearbook for 1932, the State Forest Service was responsible in the year 1930–31 for the destruction of 6,880 deer, whilst a further 12,267 deer were destroyed by private hunters.

With a view to finding a commercial outlet for the pelts of these animals the New Zealand Government approached the Imperial Institute Advisory Committee on Hides and Skins for an opinion on their value and market possibilities. The varieties of deer concerned included: Fallow, Red, Sambur, Virginian or White-tailed, Chamois, Wapiti and Thar.

The Committee recommended that a trial consignment of 50 to 100 pelts of each variety should be submitted for working trials in England since, although the ordinary value of some of the varieties mentioned is known, the quality of a pelt depends on the climatic and other conditions under which it is produced, and it would therefore be necessary to determine the value of pelts from New Zealand irrespective of the reputation which might have become established for pelts of the same types of deer from other sources.

In July 1931 a consignment of pelts was received from the Department of Scientific and Industrial Research, New Zealand, consisting of 50 Fallow deer skins; 50 Red deer skins of average weight (stags and hinds); 50 Red deer skins of light weight (fawns and young hinds).

The Fallow deer skins were obtained in the Tapanui district while the Red deer pelts were from Hanmer Springs.

The consignment was divided between two of the principal firms of deer-skin dressers in England, who had kindly agreed to carry out dressing trials. As a result the first firm reported:

"We consider these goods should have definite uses in this country, and we are prepared to make a trial of a bulk sample of 500 to 1,000 skins.

"The 75 skins we have dressed are of good quality. In the raw we noticed that they were well stretched and dried, but in the few that we have faced we find in one or

two a certain amount of damage, due to slight putrefaction before drying. From the information you have given us as to the conditions under which these skins are collected we fear that a little of this is inevitable.

" We understand that collectors have hitherto been instructed not to bring in skins with more than two shot holes. This standard is in our opinion too high, and must add unnecessarily to the cost of the goods shipped. We suggest that skins containing up to four holes but otherwise of good quality should be classed as Bests. At the same time a slightly lower selection still would also be of value, and if our suggestion to take a bulk sample of Bests is carried out, we propose that a bale of the inferior goods should be also sent for test and valuation.

" On account of the variation in size and weight of pelts we think the simplest way to market these goods would be at a price per lb. On this basis no discrimination need be made between Fallows and Reds, and our valuation to-day (December 1931) of a Best selection, defined as above, is 16*d.* per lb. c.i.f. London."

The second firm reported that of the 75 skins which they received, 16 per cent. were unsuitable except for low-grade purposes, but that the remainder were of good quality, and they offered to receive a parcel of 1,000 skins in order to carry out a large-scale commercial trial.

The results of this preliminary investigation are regarded as extremely satisfactory, and steps are being taken to arrange for the larger consignments which the two firms have asked for.

Gloves prepared from New Zealand deer skins are on exhibition at the Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2.

ARTICLES

A SURVEY OF DAMAGE BY INSECTS AND MOULDS TO WEST AFRICAN CACAO BEFORE STORAGE IN EUROPE. SEASON 1930–31.

By F. R. Passmore

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An investigation is being conducted by the Stored Products Research Branch of the Imperial College of Science and Technology into the problems of insect infestation and mould spoilage of warehouse stocks which are responsible for so much waste annually in the nation's food and raw material supplies.

A preliminary survey showed that raw cacao is frequently seriously damaged during storage in the United Kingdom by the moth *Ephestia*, which can become permanently established in warehouses. With the object of ascertaining to what extent this and other insects are present in newly imported cacao, arrangements were made with three Liverpool importers for samples of each shipment to be sent to the Stored Products Research Laboratories at Slough throughout the season 1930–31. It was also intended to make a detailed study of the mould organisms which are found in cacao in this country.

Sampling Details

It was hoped at first to secure samples to the extent of the square-root of the number of bags in each shipment, so that small lots would be represented more equably with large consignments, a system which has been tried with success for sampling purposes in the Gold Coast. Practice proved that this arrangement resulted in a number of samples far too large for the available staff to cope with, and it was abandoned in favour of a percentage of one sample-tin per hundred bags.

Altogether, throughout a season of some fifty shipments, 912 samples were received representing 87,235 bags.

The sampling and examination were carried out in the following manner:

At Liverpool, samples were drawn by official samplers, one air-tight sample tin from one bag, the bags being selected at random. The tins were closed immediately and despatched in wooden cases containing fifteen tins each. At Slough the moisture content of the beans in each separate tin was determined—for the first dozen shipments. As the season advanced and the number of samples increased, the inadequacy of available moisture-content determination apparatus made it necessary to modify this to an aggregate determination of each consignment. It became obvious also at this juncture that the variation in results was so slight as to render the more precise procedure unnecessary for all practical purposes.

From the remainder of the contents of the tins, one hundred *sound* beans were drawn and each bean cut in half. Those which were obviously internally damaged by mould or insect, i.e. " commercially damaged," were put aside for microscopic examination. Broken beans were excluded from the hundred to be examined for the following reason : cacao-beans with a rupture in the seed-coat are more liable to insect attack, and perhaps fungus growth, than sound beans, whether the rupture was caused by over-fermentation, mechanical damage or germination, and it was desired to compare the vulnerability to insect and mould damage of sound and germinated beans. Obviously this comparison could not be arrived at, if beans with the interior exposed through causes other than germination were counted.

Under the Nigerian Produce Ordinance germinated cacao is classed as defective—a measure which has given rise to considerable criticism—and it was thought that if this survey could yield it, such a comparison would be pertinent.

" Slatey " beans, that is beans the cotyledons of which are a dull, slate colour, indicating a complete lack of fermentation during preparation, also were recorded and examined, in order firstly to give a figure indicative of the degree of fermentation of the sample, and secondly to compare their immunity from biological attack with that of more fermented beans.

The results are appended.

Laycock [1] has shown by a series of experiments on the comparative susceptibility to mould attack of fermented and unfermented cacao that, contrary to previous general opinion, unfermented cacao is more immune from mould than fermented, and Dade [2], by demonstrating that fermentation provides conditions suitable for the penetration of the testa by fungal mycelium, showed why this is so.

The survey figures give some indication of the extent to which this is actually the case under commercial conditions. Slatey beans show a similar immunity from insect attack.

During the latter part of the season, when more assistance was available, a similar count was also kept of beans poorly fermented.

It is realised that the number of bags represented by the samples received at Slough is little more than one-tenth of the total imports of West African cacao throughout a season, and samples at the rate of one per hundred bags is a proportion barely adequate upon which to base generalisations as to the condition of West African cacao; also that the unequal number of samples received from Nigeria and the Gold Coast may make comparisons seem unfair. But if the sampling arrangements are open to criticism from a statistical viewpoint, it is nevertheless considered that the following deductions drawn from the survey bear sufficiently strongly upon the actual conditions obtaining in West African cacao imported by reputable firms to be of value.

Inferences on the General Nature of West African Cacao, drawn from the Results of the Survey

Average Grades.—The average cacao shipped from the Gold Coast is well within the Liverpool official grade "A, Good Fermented" which allows 5 per cent. slatey and 5 per cent. defective. Cacao from Nigeria averages 18 per cent. slatey, which would exclude it from fermented grades —Grade "C, Fair Fermented" permits 15 per cent. slatey or under—and it would be classed as "E, Fair Average Quality."

Moisture Content.—The moisture content of cacao when landed seems to bear little or no relationship with the

amount of mouldy beans present. For instance, a comparison of the figures relating to the two consignments from the Gold Coast with the highest and lowest moisture content shows :

Consignment No.	Date Landed.	Moisture.	Mouldy.	Total Defective.
		Per cent.	*Per cent.*	*Per cent.*
20	December 12, 1930	8·2	3·2	4·0
49	March 23, 1931	6·6	4·2	5·3

It has been demonstrated by Dade [2] that cacao dried to and kept at about 8 per cent. moisture content is safe from the growth of what is considered to be the most prevalent of the organisms which grow in the interior of commercially-dry cacao, that is, those of the *Aspergillus glaucus* group (Bunting [3]). Thus the moisture-content figures of the survey show fairly conclusively that cacao landed in England is safe from further moulding by known cacao fungi, unless it is stored under damp conditions. In his experiments on the hygroscopic properties of cacao, Dade (*loc. cit.*) further shows that prolonged storage in an atmosphere of 87 per cent. saturation (relative humidity) will cause cacao to reach a moisture content of 9·5 per cent., which is sufficient to support mould growth.

Experiments in the storage of copra (Passmore [4]) showed that, with such instruments as were available, the average relative humidity on the ground floor of a London riverside warehouse was 84·6 per cent. over the period March to October 1930. This included several periods when the humidity in the immediate vicinity of the copra was shown to remain above 87 per cent.—the danger-point for cacao—for more than two weeks, but it is questionable whether wet and dry recording thermometers such as were used are sufficiently delicate to show accurately day and night variations in a position where the ventilation was not good, and these figures should not be considered conclusive. It is hoped that facilities for more detailed work on this important subject of warehouse humidity conditions and their relationship with mould growth in cacao will soon be available.

Comparative Dryness of Gold Coast and Nigerian Cacao.—A significant fact which emerges from a study of the

moisture-content results is that the average figure for Gold Coast cacao is higher than for Nigerian. This is probably the result of the stringent Nigerian regulations governing the drying of cacao during preparation and, as such, bears definite relationship with the lower Nigerian average of mouldy beans. There is some evidence that cacao loses moisture during steamer transit, but it is thought improbable that the few days longer on board ship to which Nigerian cacao has been subjected would account for the difference.

Mouldy Averages Compared.—In comparing the Gold Coast and Nigerian averages of mouldy beans, it should be taken into account that the latter produce contains a much higher percentage of unfermented beans. The survey records show that poorly fermented and slatey beans bear a high degree of immunity from attack by both insects and moulds ; even after this allowance is made, however, the advantage given to Nigerian cacao by the " dry cacao " regulations is demonstrated.

Attempts to discover if the respective moisture content of germinated and slatey beans has any bearing upon their comparative susceptibility to mould growth were made by keeping samples of each under similar conditions with a control of ordinary fermented. Results showed that a similar equilibrium point was reached in all cases.

Insect Infestation.—The examination of insect-damaged cacao beans has confirmed the conclusion reached by Munro and Thomson [5] that the chief insect pests of West African cacao are *Ephestia* and *Aræcerus*, and that there is a steady influx of these and other live insects with every shipment to augment the insect population of warehouses.

Unless the insect itself in larval, pupal or adult form is actually present in the bean, the determination of the species responsible for the damage depends upon such slender evidence as may b ft, such as cast larval skins, or upon the frass being sufficiently characteristic to be recognised. With the possible exception of *Corcyra*, the frass of which is similar to that of *Ephestia*, damage caused by *Ephestia* could always be recognised and an actual figure can be given representing the comparative damage done to cacao by species of this genus. Disregarding the possibility

of damage by *Corcyra*, which is known to infest West African cacao but slightly, *Ephestia* accounts for 46·8 per cent. of the total number of beans damaged by insects. *E. elutella* and *E. cautella* were bred from larvæ found in beans. *Aræcerus* frass, while being fairly characteristic, is not sufficiently different from that of other beetles to enable a figure representing its prevalence to be given ; it was obvious, however, that the amount of damage caused by *Aræcerus* is similar to that caused by *Ephestia*.

Of the 763 insect-damaged beans examined, insects responsible for the damage to 294 were undetermined.

The following list is of the insects found during the survey in order of the frequency of their occurrence, but not necessarily in order of their importance as pests of cacao.

Ephestia elutella and *cautella*.
Aræcerus fasciculatus.
Psocids, six species including one new sp., viz. *Strenotroctes minor*, and one new var. of *Diepnopsocus speciophilus* (Pearman [6]).
Læmophlœus minutus.
Carpophilus spp. or sp.
Tribolium castaneum.
Lasioderma serricorne.
Dermestes spp. or sp.
Microbracon sp.
Oryzæphilus sp.
Bethylids, and two unidentified members of the Diptera and Hemiptera.

The relationship between mould and insect attack, if one exists, was not demonstrated by the survey. Many beans bore traces of both, but in no way could it be decided if the insect selected the bean because it was mouldy, if the mould grew subsequently to the insect's tunnelling, because of consequent infection or increased moisture content, or if separate causes resulted in the separate attacks.

Mites.—The preliminary examination of the beans was carried out on " commercial " lines and no figures can be given illustrating infestation by mites because with the

naked eye mites and mite damage are not obvious. Many beans examined microscopically for other damage were found to be occupied by mites and it is probable that the infestation is extensive.

Mould Damage.—Owing to the time required for the identification of fungi by cultural methods those beans which were growing organisms not readily recognisable were put aside for further investigation. The amount of purely taxonomic work to be done before such investigation can be completed and, consequently, before the mycological aspects of the survey can be fully reported is extensive, and some time must elapse before this mass of material is satisfactorily sorted.

Since work was started at Slough upon internal cacao moulds, in material from the Liverpool survey and cacao from other sources, the following species have been isolated which have not previously been reported as cacao saprophytes :

Aspergillus gracilis.
,, *repens.*
,, *ruber.*
,, *sydowi.*
,, *terreus.*
Syncephalastrum cinerium.
Scopulariopsis sp.
Sporotrichum flavicans var.
Penicillium citrinum (or var.).
Actinomyces cacaoi, I, II and III.
Cylindrocarpon (*Fusarium*) sp.

Throughout the survey no trace of " mustiness " was noticed in the samples received direct from Liverpool. In these laboratories experience of musty West African cacao is confined to a sample of Nigerian sent by a firm of cocoa manufacturers for investigation. The objectionable odour cannot be eradicated by processes of manufacture and it was suggested that buyers might be able to protect themselves against cacao affected in this way if the odour could be traced to a particular mould. Three variants of a species of Actinomyces were isolated from the sample and gave, in pure culture, the characteristic musty smell. They

have been described by Dr. S. Waksman and named *Actinomyces cacaoi*, I, II and III.

Abstract of Figures Relating to Cacao Survey Season 1930–31

Total number of samples examined . . .	912 (tins)
Representing	87,235 bags.

Nigeria . . .	665 samples from	73,831 bags.
Gold Coast . .	247 ,, ,,	13,404 ,,

Of the total number of 91,200 cacao beans examined, numbers damaged by moulds and insects and those which were slatey and germinated were as follows :

	Defective.	Mouldy.	Insect Damaged.	Slatey.	Germinated.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nigeria .	1,399	984	417	12,023	1,145
Gold Coast .	1,117	774	346	805	629
Totals .	2,516	1,758	763	12,828	1,774

representing average percentage of :

	Defective.	Mouldy.	Insect Damaged.	Slatey.	Germinated.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nigeria .	2·13	1·48	0·63	18·0	1·6
Gold Coast .	4·52	3·13	1·4	3·2	2·5

Average moisture content, and maximum and minimum variations.

	Average.	Maximum.	Minimum.
	Per cent.	*Per cent.*	*Per cent.*
Nigeria .	6·8	7·6	6·4
Gold Coast .	7·3	8·2	6·6

Comparative Immunity from Attack by Insects and Moulds of Various Classes of Cacao as Demonstrated by the Survey

	Insect Damaged.	Mouldy.
	Per cent.	*Per cent.*
Aggregate, all samples . . .	0·83	1·9
Gold Coast	1·40	3·13
Nigeria	0·63	1·48
Sound (ungerminated) . . .	0·63	1·8
Germinated	6·4	4·9
Slatey	0·1	0·2
Poorly fermented	0·09	0·13

Note 1.—Figures for "Sound" beans are given for comparison with "Germinated."

Note 2.—It was during the examination of the last twenty shipments of the survey that a count was made of beans "poorly fermented"; sixteen of these were from Nigeria and their figures should be compared with Nigerian, rather than with "aggregate."

The following is an abstract of the figures relating to cacao from Messrs. John Holt (Liverpool) Ltd., showing comparative percentages for the districts in Nigeria from which the samples came.

The figures are percentage averages of the total number of samples throughout the season from each district; and similar figures are also given of "Total Nigerian" and "Total from John Holt" for comparison.

Cacao imported by the firm of John Holt is from Nigeria exclusively.

No. of Samples.	District.	Defective.	Slatey.	Germinated.	Insect Damaged.	Mouldy.	Partly Fermented.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
665	Nigeria	2·1	18·0	1·6	0·63	1·4	—
223	John Holt (total)	2·2	15·3	1·6	0·4	1·7	23·3
65	Lagos	2·1	5·0	1·7	0·5	1·7	17
35	Ibadan	2·0	12·0	1·9	0·4	1·6	13
37	Ilesha	3·0	15·0	2·3	0·6	2·4	43
21	Ife	2·3	8·0	1·6	0·7	1·6	36
35	Ejinran	2·0	13·0	1·6	0·1	1·9	30
11	Okitipupa	2·4	4·4	0·4	0·5	1·9	16
9	Oshogbo	2·0	35·0	0·8	0·3	1·7	28
6	Abeokuta	0·3	7·0	1·0	0·15	0·15	13
4	Epe	1·7	3·0	0·7	0·7	1·0	8

Summary

(1) Details of the sampling arrangements for the examination of West African cacao for damage by moulds and insects are explained.

(2) Inferences from the resulting figures are drawn as to the quality of West African cacao, the comparative quality of Gold Coast and Nigerian cacao, the comparative vulnerability of slatey, germinated and fermented beans, and the relationship between moisture content and mould growth.

(3) It is shown that cacao arrives in England dry enough to prohibit known cacao fungi.

(4) The possible effects of subsequent storage are discussed and the need for further work on storage conditions indicated.

(5) A list of insects found during the survey is given, and the percentage of beans damaged by *Ephestia* spp.

(6) A list is given of the species of internal cacao

moulds, hitherto unreported, found in West African and other samples of cacao.

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DEGUMMING OF ANAPHE SILK

THE question of the industrial utilisation of Anaphe silk, the product of certain wild silkworms of tropical Africa, has been a subject of enquiry at the Imperial Institute for the past thirty years, and much experimental work has been carried out in the laboratories of the Imperial Institute and in the factories of members of the Imperial Institute Advisory Committee on Silk Production with regard to the preparation of the silk from the raw material and in investigating its possibilities for the silk manufacturing industry. An account of some of the investigations made at the Imperial Institute will be found in this BULLETIN (1916, **14**, 167 ; 1920, **18**, 319). Independently, numerous experiments have been carried out by silk firms in this country (notably Messrs. Lister & Co., Ltd.), and on the Continent, especially in Germany. The net result of these investigations is to show that if yarns could be prepared from it as a commercial proposition Anaphe silk would find an outlet in the spun silk trade as a material having definite value for certain classes of fabric and especially for velvets ; while there is good evidence that it would also prove valuable for admixture with wool. The silk is deficient in lustre, but has a pleasing colour (it can if necessary be bleached), and takes dyes well ; its strength is satisfactory.

Commercial utilisation depends upon two factors : the

cost of production of the degummed silk and yarn, and availability of supplies. Hitherto, the cost of the degummed silk has been excessive as compared with waste silks mainly on account of the relative difficulty of degumming the " nests " and the low proportion of final combed drafts available for spinning into yarns. As regards the " difficulty " of degumming, it has long been evident to the Imperial Institute Committee that if Anaphe silk (raw material) were cheaply available in large quantities satisfactory methods of degumming would rapidly be evolved.

The real difficulty is the availability of supplies of the silk. A number of species of the Anaphe moth occur in tropical Africa, mainly in West Africa, the Congo, and East Africa, especially Uganda. Attempts have been made to organise supplies of the raw material, the most recent being the efforts of the African Silk Corporation, Ltd., in British West Africa and Uganda. No real success has attended these efforts, though consignments of the silk appear on the market from time to time at the instance of the trading companies. The probability is that " wild " supplies of the silk do not exist in sufficient amount to support an important regular export trade, and that a permanent industry could only be maintained by the semi-domestication of the worm in plantations of its food trees. The expense of such organisations might prevent the silk being marketed at a competitive price, and no regular attempt to work on these lines has been made for many years.

Recently the Government of Uganda, in anticipation of future development in Anaphe silk, have issued an Ordinance entitled " The Wild Silk Ordinance (1931)." This restricts the purchase and export of wild silk to licensed dealers, prohibits the degumming of the silk except under licences, and empowers the Governor to make rules to regulate and control the purchasing and exporting of the silk.

The Anaphe nests which have been considered hitherto in the silk industry are of two main types, viz. (1) the *A. infracta* type, in which the colony of cocoons is contained in a tough parchment-like nest more or less globular in

shape ; and (2) the type represented by *A. moloneyi*, in which the flat cocoon mass is protected by a comparatively loose silky cover. In the former case the greater part of the silk for industrial purposes is derived from the " parchment " layer, while in the second type (as hitherto received in this country) the cocoon mass yields most of the silk: the protective covering of this type of nest has usually been removed by weathering or other causes in material so far received in Europe. The morphological differences between the two forms of nests, which are not always recognised, explain the variations met with in the results of degumming and carding experiments with " Anaphe silk."

Many experiments have been made on degumming Anaphe silk at the Imperial Institute and elsewhere. In 1930 an investigation was carried out in the laboratories of Messrs. Murray, Bull & Spencer, Ltd., of South Kensington, and a copy of the report on the work, by H. D. Murray, B.A., A.I.C., was furnished to the Imperial Institute. The results are of much interest and, with the author's permission, the report is now published. It should be noted that the prices mentioned relate to the position in 1930 and are correct at that date ; they would of course need some amendment at the present time.

EXPERIMENTS ON DEGUMMING ANAPHE SILK

By H. D. Murray, B.A., A.I.C.

Material

The sample submitted was stated to consist of the nests of *Anaphe moloneyi*. In each nest it was possible to distinguish five distinct portions, first the chrysalis proper, secondly an inner hard thin silken cocoon surrounding the chrysalis, thirdly a softer outer cocoon strongly adherent to the inner, fourthly connective silk tissue in which the cocoons were embedded, and fifthly a hard outer casing completely surrounding the nest.

The problem involved was to treat the whole by some simple and cheap process so as to separate the silk fibres from the substances cementing them together and to leave the fibres in such a state that the resulting products might

be put to those uses to which silk waste, for example, is put. That is to say that the product, after opening and carding, should be suitable for spun silk materials. At the same time the process involved should remove only such quantity of sericin or gum as might be necessary to separate the fibres, and the chemicals applied to the silk should have no immediate or delayed deleterious effects upon the strength or appearance of the fibres.

Experimental

It was found that the cocoons contained chrysalides. This appears to be a disadvantage, first because the weight of the contents of the chrysalides is high compared with the total weight of silk imported, secondly because, in soaking the nests before treating, extremely offensive putrefactive changes occur unless large quantities of disinfectant are added to the mass. It would appear best, unless the emerging moths damage the nests in any way, to gather the latter at such a period of the year that the cocoons are empty.

Bacterial or Enzyme versus Chemical Methods

It was found that the silk could be softened and partially degummed by soaking for several weeks in water containing suspended chalk but, as the accompanying putrefactive changes in the chrysalis bodies were so unpleasant and as a chemical method had then been worked out, the latter was adopted.

Outline of Chemical Method

It was found that mild oxidising agents acting in alkaline solution softened the gum and enabled the silk to be boiled off satisfactorily. Barium peroxide, sodium perborate or hydrogen peroxide could be used, but the last was preferred as it was more regular in its action. Preliminary experiments gave a very brittle product, but it was found that this could be obviated by having a colloid in the oxidising bath. Gelatine could be used but sodium silicate was eventually adopted to furnish both the colloid

and the alkali. The method finally worked out was as follows :

(*a*) The silk was boiled in a 2 per cent. solution of sodium carbonate containing a small quantity of a wetting agent, such as Brilliant Soap or "Perminal" for half an hour. It was rinsed and squeezed dry in a press. This treatment removed the contents of the chrysalides together with a certain amount of dirt.

(*b*) The nests, which were still adherent and apparently unaltered, were then boiled for three quarters to one hour in :

Water	200 litres.
Sodium silicate	500 gms.
Hydrogen peroxide (20 vols)	900 c.c.
Crude glycerine	1,000 c.c.

In this bath the nests were well stirred and slowly disintegrated. At the same time the silk was bleached to a light cream colour. The product was rinsed and squeezed dry. It was then boiled off in the usual way in a soap bath containing an amount of soap equal to 5 per cent. of the weight of the original nests. The product was found to be improved by adding to the bath 0·5 per cent. of gelatine and 0·4 per cent. of 20-volume hydrogen peroxide. The silk was then thoroughly rinsed in several changes of tepid water, passed through a bath of dilute sulphurous acid, squeezed and dried with warm air. The sulphurous acid treatment is optional, but it prevents the silk matting if dried rapidly at comparatively high temperatures.

Yields

At the time of beginning these experiments we had 56·3 kilos. of raw silk. The casing was stripped from the body silk; and sticks, etc., were cleaned out during the stripping. This left 47·0 kilos. of raw body silk and 4·8 kilos. of raw casing silk. These figures give the following data :

Percentage of foreign matter removed during stripping	9·2 per cent.
Ratio of raw casing to raw body silk	10·2 „ „

Forty kilos. of the body silk were treated in five batches of 8 kilos. each. The whole of the casing was treated

in one bath of 4·8 kilos. The yields of finished silk were as follows:

Batch No.	Final Weight.	Percentage Yield.
1	3·29 kilos.	41·1
2	3·52	44·0
3	3·40	42·5
4	3·64	45·5
5	3·35	41·9
Total treated body silk	17·20	43·0
" " casing silk	3·39	70·7

The casing silk gives a much higher yield owing to the absence of chrysalides. The ratio of treated casing silk to treated body silk is about 17 per cent. as compared with 10·2 per cent. for the raw silks. The casing silk gives a very beautiful product, much whiter and superior to the body silk.

Costs of Degumming

Per lb. of raw body silk	4*d.*
" " treated body silk	10*d.*
" " raw casing silk	7*d.*
" " treated casing silk	10*d.*

These costs depend to some extent upon the number of times which the second and third solutions can be used. By allowing each to settle overnight they can be used at least five times, provided fresh hydrogen peroxide is added to the second solution each time it is used, and this figure has been adopted in our calculations. The latter are based upon prices paid by us for comparatively small quantities of chemicals and gas for heating. The figures may therefore be taken as maxima.

Yield of Cost and Spinning

Body and casing silk were mixed and spun together. They gave a yield of 33⅓ per cent. at a cost of 29·4*d.* per lb. of finished yarn. We understand that this yield could probably be improved by care to between 40 and 50 per cent., but the figure 33⅓ has been adopted in the following calculations:

Total Cost of Spun Silk

One pound finished yarn requires 7·14 lb. of raw nests.

[1] Purchase of 7·14 lb. raw nests . . .	28·6*d.*
[1] Duty on 7·14 lb. raw nests . . .	71·4*d.*
[1] Carriage on 7·14 lb. raw nests . . .	10·8*d.*
Degumming 7·14 lb. raw nests . . .	29·8*d.*
Estimate for labour, overhead charges, etc.	9·6*d.*
[1] Cost of spinning	29·6*d.*
	179·8*d.*

[1] *These figures have been communicated to us. We take no responsibility for their accuracy, though we believe them to be correct.*

Thus 1 lb. of spun silk costs about 15*s.*

Conclusions

The market price of the product has been estimated as 12*s.* per lb. The process is therefore uneconomical as long as the full duty is charged on the nests. This duty amounts to practically 40 per cent. of the cost of the spun yarn.

Even with the duty enforced, a considerable saving in cost could be effected by carrying out the initial treatment of the silk in West Africa. This initial treatment consists in boiling for two hours in a dilute solution of soda, rinsing and drying. Such a treatment could well be carried out under primitive conditions by native labour, and would materially reduce the cost of the final product. Slightly more than one-half of the weight of the imported material, upon which carriage and duty is paid, consists of chrysalis bodies and dirt. These are removed during the initial treatment, leaving only raw silk and empty chrysalis cases to be brought to England.

The same effect would be brought about by gathering the nests after the moths have hatched out, but we understand that this is impracticable, partly on account of local weather conditions and partly because the nests are damaged by the moths as they leave.

When the nests reach England, however, the moths are still alive and large numbers have hatched out during the summer months without apparently damaging the nests they left.

NOTES

Palm Oil for Fattening Poultry.—The Imperial Institute was recently consulted by the Malayan Information Agency regarding the suitability of Malayan palm oil as a substitute for mutton fat in the fattening of poultry. As there appeared to be no record of the use of palm oil for this purpose arrangements were made with Mr. E. T. Halnan, of the Animal Nutrition Institute, Cambridge, for a feeding trial to be carried out. The sample of oil used in the experiment was supplied by the Malayan Information Agency and represented the best grade of palm oil produced on plantations in Malaya. As the following report shows, the results of preliminary trials were quite favourable, and it is proposed to arrange for a commercial test of the oil as suggested by the authors.

On the Suitability of Palm Oil as a Mutton-Fat Substitute for Poultry Fattening Mixtures

By E. T. Halnan, M.A., and E. M. Cruickshank, B.Sc., Ph.D.,

Poultry Nutrition Section, Animal Nutrition Institute, Cambridge

As the result of a request from the Director of the Imperial Institute, an investigation into the possible value of palm oil as a mutton-fat substitute for use in poultry fattening mixtures has recently been undertaken at Cambridge.

Palm oil is an Empire product, and consists of the pericarp oil of the palm fruit. The sample supplied to us was of British Malayan origin. The oil is solid at normal temperatures in this country. It is bright orange in colour, and possesses a slightly aromatic odour. From the chemical characteristics given below, there was good reason to think this product would prove suitable for use as a mutton-fat substitute.

Fat.	Saponification value.	Iodine value.	Percentage of solid acids.	Molecular weight.
Palm oil . . .	194·5	53	46·3	265
Mutton fat . .	195	41	54·7	—

An experiment was therefore designed to ascertain answers to the following questions :

(1) Is the orange colour of the palm oil transferred to the body fat, thus causing pigmentation of the fat with consequent deterioration in quality of the carcase ?

(2) Is the chemical composition of the fat so deposited

of such a nature as to militate against the use of palm oil for fattening ?

(3) Is the flavour of the carcase affected in such a way as to render the carcase unpalatable ?

To answer these questions, four Light Sussex cockerels of approximately four months of age were divided into two groups of two birds, and were fed on the following mixtures :

LOT "A"

Sussex ground oats	13
Dried skim milk	3

LOT "B"

Sussex ground oats	13
Dried skim milk	3
Palm oil	8 per cent. of the above mixture.

The birds were housed in suitable wire cages under laboratory conditions and were given free access to these mixtures, fed in the form of wet mash. After 16 days trough feeding, the birds were killed and dressed, and after samples of body fat had been taken for chemical analysis, were roasted in an oven and subjected to palatability tests. The carcases from both lots of birds presented an attractive appearance and the body fat was not pigmented in any way. Therefore the presence of this pigment in the palm oil need not be regarded as an argument against its use for fattening purposes.

The palatability tests also were favourable. Nine individuals sampled the material, and in no case could the slightest suspicion of an undesirable flavour be detected. Indeed, with regard to the palatability of the two lots of birds, the consensus of opinion was more favourable to the lot to which palm oil had been given, this being doubtless due to the fact that more fat had been deposited in the body tissues of these birds, giving them a richer and more succulent flavour.

The constants of the body fats from the two lots, as ascertained by Cruickshank, were as follows :

Analysis of body fats in Light Sussex fattening experiment

	Fat.		Mixed fatty acids.	Solid acids.		Liquid acids.		
	Sap. val.	Iod. val.	Iod. val.	Percentage.	Mol. wt.	Iod. val.	Mol. wt.	Sap. val.
Palm-oil fed birds .	193	71	73	30·6	264	106	281	199
Normal fed birds .	193	72	75	30·9	265	109	281	198

Comparison of the constants given indicates quite clearly the fact that the composition of the body fat of the

bird is not altered to any appreciable extent by the use of palm oil under the conditions of this experiment. Under prolonged feeding of palm oil, facts in our possession derived from other considerations would lead us to believe that a change in the composition of the body fat would eventually take place, but since under Sussex fattening conditions fat is rarely fed beyond a period of 10 to 14 days such a change would not be expected to occur under commercial conditions. From the constants given it is apparent that birds fed with palm oil to the extent of 8 per cent. of the fattening mixture will deposit a fat, the consistency, colour and flavour of which will be of the normal type that one associates with a high-quality carcase.

It is desirable that this experiment, which is of a preliminary nature, should be carried out on a commercial scale. The evidence that our experiment affords leads us to expect that such an experiment would confirm in every way the findings recorded above.

Empire Cocoa.—The Imperial Economic Committee have recently issued, as the twenty-second of their reports on the preparing for market and the marketing of foodstuffs and raw materials produced within the Empire, a valuable survey of the cocoa industry (H.M. Stationery Office, 1932, price 6*d.*).

The world's production of cocoa is approximately 500,000 tons, of which 60 per cent. is of Empire origin; British West Africa supplying half of the world's total. In consumption, the United States of America is easily first, taking about 37 per cent., followed by Germany with 15 and the United Kingdom 12 per cent. Holland and France come next and these five countries together consume 80 per cent. of the world's output. Continuing the analysis of Empire production a little further we find that the approximate outputs in tons are Gold Coast 244,000, Nigeria 49,000, Trinidad and Tobago 29,000, and the rest of the Empire 12,000, of which Grenada, Jamaica and other West Indies islands produce about 8,000 and Ceylon 3,500. In the Empire there are thus two chief producing areas—West Africa and the West Indies. The conditions in these two regions are very different, as also are the problems confronting the producers, and the Committee take the Gold Coast and Trinidad as the two representative countries, and deal with them in considerable detail.

The first point to notice is that of quality. As is well known the highest is Criollo, but the world's output of pure Criollo is now negligible ; the Committee put it at 1,000 tons or 0·002 per cent. What are described as " near

Criollo " cocoas are produced in Ecuador, Venezuela, Java and Ceylon. The Empire's contribution to this group is very small. The mass of the world's production is made up of the Fine or higher Forastero cocoas of Trinidad, Grenada, etc., and the Bulk or lower Forastero cocoas of West Africa and Brazil. Fine cocoa, e.g. Trinidad, commands, on its merits, a higher market value than Bulk cocoa, e.g. Gold Coast, but the price margin tends to narrow because Gold Coast cocoa, being available in such large quantities and being cheaper, is used in increasing proportion in manufacturers' blends.

In Trinidad the main problem facing planters is, whilst at least maintaining the standard of quality, to reduce the cost of production. The Committee deal in detail with the weak points in the industry, and also note the good work done through the Government Agricultural Bank, bodies such as the Cocoa Planters' Association and, of more recent growth, peasant co-operative bodies. They strongly urge, however, that in the future much will depend on the efforts the planters make to carry into effect the lesson taught by the Department of Agriculture's work at River Estate that the large number of poor bearing trees must be replaced by higher yielding strains. They also recommend that the question of instituting compulsory grading and inspection should be reconsidered, and generally that more official help should be provided to bridge the gap between current knowledge and practice.

In the Gold Coast, on the other hand, the main need is improvement in quality and in marketing methods, not reduction in cost of production. After a detailed survey of marketing methods there and also in this country, the Committee state that the existing methods, " the outcome of primitive trading conditions, are no longer adequate to ensure an economic inducement to the African cocoa farmer for greater care in the preparation of his produce. Much will depend on the progress of the scheme for co-operative marketing and up-country certification of cocoa which has been inaugurated by the Gold Coast authorities." Improved agricultural methods are also advocated and amongst other means the use of talking films is suggested.

Many other subjects of importance are dealt with in the Report, including the manufacturing and advertising of cocoa products, the question of cocoa butter and its substitutes, the function of research, etc.

It will suffice to say in conclusion that this report affords an excellent survey of the Empire cocoa industry and is well worthy of the careful attention of all interested,

whether as producers, dealers, manufacturers or consumers of this product.

Damage to Timber by Lyctus Beetles.—The importance of the damage to timber and manufactured timber goods resulting from attacks by Lyctus (powder post) beetles is being increasingly recognised by the timber trades throughout the country and the carrying out of effective measures to deal with the problem is a pressing need among the industries concerned. The Lyctus beetle attacks the sapwood of certain hardwoods, the most important being oak, ash, walnut and elm ; the eggs are laid in the pores of recently or partly seasoned wood, and the tunnelling of the grubs and the final emergence of the beetle result in serious damage to the timber accompanied by characteristic accumulations of finely powdered wood. The present unfortunate state of infestation in this country has resulted very largely from the import after the war of American oak and ash carrying the pests and the subsequent neglect of action to deal at once with the new menace.

The results of " A Survey of the Damage caused by Insects to Hardwood Timbers in Great Britain," which was carried out by the Forest Products Research Laboratory, Princes Risborough, with a view to obtaining as full information as possible regarding the extent and conditions of the Lyctus infestation (and the damage caused by other less important pests) as a preliminary to determining suitable control measures, have been published in *Bulletin No. 16* (1932), *Forest Products Research* (Department of Scientific and Industrial Research). In carrying out this survey, dock and timber storage wharves were visited at all the chief timber ports, and, in addition, timber was inspected on the premises of 333 importers, merchants and users in the principal timber-using centres in England and Scotland. The immediate object was to ascertain how far the present Lyctus problem is due to (*a*) importation of infested timber, (*b*) subsequent infestation after entry into this country, and (*c*) increase of damage by Lyctus species already known to occur in Great Britain. The results of the work show that all three causes are at work. Infested timber is being imported, although it is recorded that the United States Department of Agriculture, Bureau of Entomology, is advising exporters to sterilise hardwoods by kiln treatment before shipment. " The time is now ripe for united effort on the part of importers at home and exporters abroad to take steps (e.g. by kiln sterilisation treatment, by rigid systems of inspection, by segregation of infested timber and by the adoption of quarantine meas-

ures, etc.) to ensure that timber is free from Lyctus powder pest beetles." On the other hand causes (*b*) and (*c*) above are also factors in the situation, and the measures desirable in this connection are discussed in the report. It is considered that immediate steps should be taken to control the spread of Lyctus beetles in this country, and the view is expressed that co-operative action by those concerned would result in a widespread demand for wood guaranteed kiln-sterilised or otherwise free from attack.

The discussion of this problem and recommendations in regard thereto will be of much service to all trades anxious to reduce losses caused by timber beetles.

On page 19 of the Bulletin the "country of origin" of Waika timber (*Symphonia globulifera*) is inadvertently stated to be West Africa instead of Central America (British Honduras).

Imperial Institute Publications on Mineral Resources.—*Lithium.*—A recent addition to the Imperial Institute series of publications on the Mineral Industry of the British Empire and Foreign Countries is a brochure on *Lithium*, issued by H.M. Stationery Office, price *6d.*

Until recently, lithium was employed only in the form of its salts, chiefly in the treatment of rheumatism. Now, however, the metal itself is being successfully used abroad both as a constituent of various light alloys, and also for hardening such metals as aluminium and lead.

The utilisation of lithium salts has, moreover, been extended in certain directions, the hydroxide, for example, being now used in increasing quantities in the manufacture of "alkaline accumulators," which are stated to be very suitable for use on motor-cars and in wireless apparatus.

Many other interesting applications of lithium and its compounds in the glass, ceramic, and enamelling industries are known, and accounts of these will be found in the above publication, which deals particularly with the natural sources of the metal, its preparation and uses. Details are also given of the world's production and marketing of lithium minerals, in addition to a description of their occurrence in both British and foreign countries. In this latter connection it is interesting to note that the British Empire has important resources of lithium minerals, particularly in Canada, Australia, Union of South Africa, and South West Africa, some of which have been worked.

This brochure, which concludes with a selected and classified bibliography, should prove of service to those interested in this metal or its compounds.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Ceylon.—The following report of the Chemical Division, Department of Agriculture, during the period January 1–June 30, 1932, has been furnished.

(*a*) *Leaching and Drainage Trials.*—These entered their sixth year in January. The 1931 leachates have been analysed and the results partially worked out. These latter confirm generally those obtained in previous years.

(*b*) *Green Manure Experiments.*—Two experiments have been started at the Experiment Station, Peradeniya, to determine (*a*) the amounts of nitrogen, if any, fixed in the soil by a leguminous crop (*Calopogonium mucunoides*) under Peradeniya conditions; (*b*) the effects of green manuring alone and in conjunction with artificial nitrogenous fertilisers on the carbon and nitrogen contents and reactions of soils at Peradeniya. There are four treatments in each experiment, each replicated four times, the arrangement being in the form of Latin squares. The results will therefore lend themselves to statistical examination. Fair progress has already been made with the analyses of the initial soil samples.

(*c*) *Soil Investigations Relative to Paddy* (*Rice*) *Cultivation.*—Considerable progress has been made with this investigation during the half-year under review. The *maha* paddy (rice) crop was harvested at the end of March. All samples of both crop and soil have been analysed and the results worked out. The investigation carried out in co-operation with the Division of Economic Botany has been the most comprehensive that has yet been undertaken by this Division since its inception. Results of great practical value as well as of fundamental scientific importance on paddy cultivation have thus been secured. The experiments have clearly demonstrated the value of ammonium phosphate, superphosphate and green manures, and superphosphate alone, in increasing yields, the mean percentage increases over the controls obtained being as high as 59, 39 and 30 per cent. respectively. Hence the importance of manuring if good yields are to be obtained on the intrinsically poor rice soils of Ceylon.

The examination of the crop analytical data indicates that under Ceylon conditions the rice crop continues to assimilate plant nutrients up to the time of ripening of the grain. This is in accordance with the conclusions found in India. At flowering only about 50 per cent. of the dry matter, nitrogen and total ash have been absorbed by the plant. The mineral constituents, potash and lime, have, however, been assimilated to the extent of about 75 per cent. at this period. At harvesting, the grain contains about 75 per cent. of the nitrogen, 90 per cent. of the phosphoric acid, 30 per cent. of the lime and 20 per cent. of the potash, while the straw contains about 20 per cent. of the nitrogen, over 75 per cent. of the potash and 65 per cent. of the lime of the entire plant.

In regard to the percentage composition of the plant at various stages of growth, the average dry matter content shows a fall after transplanting followed by a steady rise; the nitrogen content a steady fall until the half-ripe stage and then a slight increase. The percentages of total ash constituents generally show a decrease up to about a month after transplanting, then an increase and finally a decrease. At harvesting the grain contains the highest nitrogen and phosphoric acid percentages and the straw the highest percentages of lime and potash.

The various treatments affect the composition of the crop at different periods of growth differently. In the early stages of growth the crop from the ammonium phosphate plots contains the highest percentage of nitrogen, but in the later stages the crop from the green manure and control plots appear to be best in this respect. The percentage of phosphoric acid is all along highest in the crop from the ammonium phosphate plots, while that from the controls is lowest in this constituent.

The crop from the ammonium phosphate plots generally contains the highest total amounts of nitrogen and phosphoric acid at harvesting, while that from the controls contains the lowest amounts of these constituents. Phosphoric acid appears to be the limiting factor of yield on these rice soils. The average amounts of fertilising constituents taken up by a crop of paddy when cultivated and manured as in this experiment, are as follows:

	Nitrogen.	Phosphoric acid.	Potash.	Lime.
		lb. per acre.		
Control plots . .	22·4	8·2	34·8	17
Manured plots .	32·2	12·8	46·5	21·6

As for the soil changes, there is an appreciable decrease in total soil nitrogen and carbon at harvesting as com-

pared with that at the start of the experiment, the highest fall in nitrogen being in the case of the controls. The least fall in carbon is in the green manured plots. The water-soluble phosphoric acid and P_H values show no appreciable change during the growing period in the different plots. The highest amounts of soil-exchangeable ammonia throughout the growing period are found in the ammonium phosphate and green manured plots and the least in the controls. The amounts of this soil constituent decrease as the crop advances in growth. The final amounts of soil-exchangeable ammonia are much less than they were at the start of the experiment. As regards other base exchange constituents, the fall is greatest in the case of exchangeable potassium. This is correlated with high potash contents in the crop. The fall in exchangeable lime is proportionately less and so are the amounts of lime assimilated. Exchangeable calcium forms about 70 per cent. of the total exchangeable bases of these paddy soils.

The second experiment to determine the residual value of the manures and fertilisers previously applied has been started this *yala*, and crop and soil samples are being taken periodically for examination.

(*d*) *Soil Erosion Investigations.*—The soils from the soil erosion experiment plots at the Experiment Station, Peradeniya, are being analysed after a period of five years to determine in what way the treatments have affected the soil constitution. The eroded soils are also being analytically examined with a view to determining the nature of the eroded material and the total amounts of the various fertilising constituents of the soil that have been lost through erosion. The experiment is to be continued in a modified form from August this year in order to include measurements of the surface " run-off " as well.

(*e*) *Soil Studies.*—An investigation has been started, in co-operation with the Government Mineralogist, to determine the mode of formation and occurrence of laterite (cabook), the characteristic soil-forming material in the South and West of Ceylon.

According to the half-yearly report of the Experiment Station, Peradeniya, for January to June, 1932, an experiment in the measurement of soil erosion from steep tea land planted with *Gliricidia maculata* (*a*) with a cover of *Indigofera endecaphylla*, (*b*) with contour hedges of *Clitoria cajanifolia* and (*c*) with no treatment, was brought to a conclusion at the end of May after running for six years.

During the first year no cover crops or hedge plants

were planted with a view to comparing the relative erosion in the different plots before and after planting.

Taking the loss of soil from the control plots as 100 the following losses were sustained :

	Controls.	Indigofera plots.	Clitoria plots.
Year before planting . . .	100	85·4	122·0
During five years after planting .	100	51·3	75·2
Last year only . . .	100	29·4	54·7

The calculated losses of soil per acre over the whole period of six years were control plots 101·8 tons, *Indigofera* plots 56·7 tons, *Clitoria* plots 75·2 tons.

The report of the Systematic Botanist's Division for the period January–June, 1932, contains the following suggestions regarding various plants that should be grown on the Iranamadu bund for preventing soil wash by wave action and wind and rain erosion.

In the first case *Tamarix gallica* L., *Parkinsonia aculeata* L., *Vetiveria zizanioides* Stapf and *Saccharum spontaneum* L. were recommended for planting near the foot of the bund. At this position their roots would get sufficient moisture when the water in the tank was low, and when the water was at a high level these plants should be able to withstand partial submergence. Further, these species would not choke the canals leading from the tank.

Wind and rain erosion should be effectively dealt with in this dry region by growing the following species which could be obtained locally if not at present on the bund.

Mimosa pudica L.
Hyptis suaveolens Poit.
Tephrosia purpurea Pers.
Cassia occidentalis L.
Cassia Tora L.
Sida acuta Burm.
Lippia nodiflora Rich.
Xanthium Strumarium L.
Ipomœa spp.
Aristida setacea Retz.
Cynodon Dactylon Pers.
Chloris spp.
Perotis indica O. Ktze.
Apluda mutica L.
Aloe vera L.
Sanseviera zeylanica Willd.
Elephantopus scaber L.
Rhyncosia spp.

The absence of finer particles of soil on the bund was noted, so it was recommended that weeding and burning of the plants at present on the bund should be stopped.

Cover Crops

Uganda.—In his report for the half-year ending June 30, 1932, Mr. P. Chandler, Plantation Manager, Serere Experiment Station, states that one new introduction

under the name of *Stizolobium deeringianum*, and one re-introduction under the name of *Phaseolus calcaratus* have been made during the period under review. Both these have come from the Bukalasa Experiment Station. The latter was originally known here under the name of "Burmese Soy Beans."

The following are among the other crops being tried at the Station.

Soy Beans (*Glycine hispida*).—One quarter acre was sown on April 20, with a seed rate equal to 80 lb. per acre. Grown primarily for seed, a very dense cover resulted during the following month, which was very wet (9·41 in.); many of the plants attained a height of 2 ft., which together with the heavy cover fully justifies its inclusion as a quick-growing cover crop under suitable conditions.

Harvesting began on July 5, and although incomplete at the time of writing everything points to a record crop.

Crotalaria alata.—This is now the second year of trying out this particular plant and last season's three outstanding characters have been well maintained in a one-quarter-acre plot growing this year. These features are the extremely slow germination of the seed, the subsequent slow growth and the rather thin habit, all of which render it almost valueless for a cover crop compared with some others.

This year the seed rate was increased to the equivalent of 60 lb. per acre, but even this is not much good on account of this slowness, too much soil erosion taking place, and expenditure for keeping weeds down in the meantime is incurred.

Although the seed was sown in April, it took nearly till the end of June before the plants really branched, they then being about 12 in. high. Flowering also commenced about this time.

Witch Pea (*? Lathyrus sativa*).—It is the first season of having this under trial. About 100 plants were raised from about 3 to 4 lb. of seed which became badly attacked by "pea-weevils" since its receipt towards the end of last year. Like *Crotalaria alata* it has a rather slender habit and thin leaves, but has the advantage of being somewhat quicker in growth. Further trials are needed on a larger scale before a definite conclusion can be formed.

Pests

Eelworms

Ceylon.—According to the report of the Mycological Division, Department of Agriculture, for the half-year ending June 30, 1932, Mr. W. C. Lester-Smith has given

some attention to the eelworm diseases of Ceylon, and the following notes have been furnished.

The discovery of the citrus root nematode (*Tylenchulus semi-penetrans* Cobb) is recorded (see p. 334).

The Ceylon host-list of the ubiquitous "root-knot" eelworm (*Heterodera marioni* (Cornu) Goodey = *Heterodera radicicola* (Greff) Muller) has been considerably extended. Records which are new to Ceylon and elsewhere, are *Strobilanthes dyerianus* (Acanthaceæ) and *Exacum zeylanicum* (Gentianaceæ); the latter being the first record of this eelworm attacking a plant belonging to this family. For the control of this eelworm, which exhibits considerable host selection at times, the question of trap-cropping in addition to crop rotation requires consideration. If a cheap and rapid-growing trap-crop can be found, this might prove a distinctly economic method of control.

Termites

Ceylon.—The report of the Entomological Division, Department of Agriculture, for the half-year January to June, 1932, states that *Calotermes* (*Neotermes*) *militaris* has been recorded in *Cedrela toona* and *Calotermes* (*Neotermes*) *greeni* in *Casuarina equisetifolia*. These are new host plant records for these species of termites.

The investigations in connection with the injury done to estate factory buildings and to bungalows by termites of the genera *Cryptotermes* and *Coptotermes* have been continued.

The biology of some of these species of termites is being studied, and winged adults of *Cryptotermes perforans* have been produced during the period under review from neoteinic adults after a period of two and a half years.

The tests with various building materials are being carried on, with special reference to their resistance to termite attack.

Beverages

Cocoa

Nigeria.—The following report from the Botanical Section, Southern Provinces, covering the period January to June, 1932, has been compiled by Mr. O. J. Voelcker.

As was mentioned in the previous report (this Bulletin, 1932, **30**, 205), 49 trees were chosen at the end of the 1930–31 season from a plot of 450 Forastero trees at Ibadan, and formed the preliminary selection. The 1931–32 season has supplied data to reduce the number of selections

to ten, which is thought to be a convenient population. Over the previous ten years the number of pods per tree had been recorded. In order to reduce this figure to the more useful one of wet beans per tree, it was found necessary to obtain these weights for each tree at each harvest throughout the main 1931–32 season. As was to be expected, these weights did not correspond exactly with the number of pods; in fact several trees which bore a large number of pods actually produced less wet cacao than certain indifferent yielders. From the resulting order of the 49 trees, ranged according to the calculated yields of wet beans over eleven seasons, the first three were automatically selected, and the lowest fifteen discarded. Seven further selections were then made, judged upon the general appearance of the trees in the plot, but bearing in mind their previous yields and the average size of their beans. With possibly one exception, all ten selections are of a very similar yellow amelonado type.

Self-fertilisation of these trees, which is now in progress, was postponed till the last week in April; from experiments conducted in 1931 it was found that artificial pollination in March and early April was unsatisfactory owing to the high percentage of shedding at a later date.

Data obtained from individual records of the number and weight of pods, weight of wet beans and the number of bad pods, of the 49 trees at each harvest of the main 1931–32 season, show the following points:

(i) The weight of wet beans per pod generally falls continuously from the beginning of the main season, and reaches about half its original value at the end of this period. This is of importance where it is required to reduce a yield in terms of the number of pods to one of weight of wet beans—the factor obtained from one harvest only being misleading, and liable to produce a totally inaccurate figure.

(ii) Similarly, the weight (and size) of wet beans varies at each harvest, becoming progressively smaller towards the end of the season.

(iii) The weight of one pod from any tree, though generally an index of the contained beans, is by no means always so. Several trees produce fine large pods which actually contain less wet cocoa, pod for pod, than smaller pods harvested from other trees.

(iv) The number of diseased pods recorded per tree was very small, averaging about 4 per cent. Regular harvesting at three weekly intervals no doubt largely accounted for this. On certain trees more damage was done by a species of black ant than by fungus diseases.

In selection two other factors suggest themselves and will be investigated. These are :

(i) The percentage of dry to wet cocoa for individual trees, and the variation according to the time of year.

(ii) The period of delivery of the crop. A tree consistently yielding only during the main season is more advantageous than one whose crop is produced in driblets throughout the year. Probably both hereditary and soil factors account for the difference.

Coffee

Nigeria.—The following report from the Botanical Section, Southern Provinces, covering the period January to June, 1932, has been compiled by Mr. O. J. Voelcker.

Although Liberian types of coffee (*Coffea liberica*) grow and yield well throughout the Southern Provinces, the market dislike, and consequent low prices, prevents any extensive planting up. Introduction of other species was made during 1931, for trial at Ibadan and other agricultural stations. The following types were introduced :

From Java (General Experimental Station, Buitenzorg).	Robusta (*C. robusta*). Quillou (*C. robusta*—var. *Quillou*). Uganda (*C. robusta*—var. *Uganda*).
From the Gold Coast (Department of Agriculture).	Robusta (*C. robusta*—variety unknown.

Other coffees available in Nigeria are :

C. arabica, *C. stenophylla*, Bengal ? (*C. bengalensis ?*) and *C. liberica*.

The first consignment of seed from Java germinated so indifferently that a further quantity was requested, and was very kindly supplied by the Director of the Experimental Station, Buitenzorg. With the exception of Quillou, germination was more satisfactory. A further supply of seed from the Gold Coast was also most generously supplied.

At Ibadan a half-acre plot each of Liberica, Gold Coast Robusta and Arabica was planted in 1931. This year similar plots of Stenophylla, Bengal ?, Java Robusta and Uganda have been established, with, on account of poor germination, a quarter acre only of Quillou. With the exception of Arabica (8 ft. × 8 ft.) and Stenophylla (10 ft. × 10 ft.) all are planted 12 ft. × 12 ft. square. Gliricidia shade (*Gliricidia maculata*) was set out between alternate rows of coffee throughout the block in 1931, and *Albizzia falcata* shade was planted 40 ft. × 40 ft. Ibadan

is subject to intermittent harmattan (a prevailing dry dust-laden wind from the north) during the long dry season, and it is probable that even with a heavy shade the more delicate coffees will suffer. For this reason quarter-acre plots of the Java and Gold Coast coffees have been planted at Benin and at Umu-ahia agricultural stations. Again at Benin, on account of the poor germination, only a few Quillou plants were available. Liberian types grow well at both these stations, but it was considered that under the low altitude tropical rain forest conditions which characterise them, Arabian coffee, essentially a hill type, was not worth a trial. Albizzia and Gliricidia shade is used at Umu-ahia, and Albizzia alone at Benin. A marketable coffee which grows well on the Benin Sands (a formation extending over a large area in Southern Nigeria) would be especially useful, since cocoa cannot be readily established on these soils.

Tea

Ceylon.—According to the half-yearly report of the Entomological Division, Department of Agriculture, January to June, 1932, the investigation of tea termites (*Calotermes* spp. etc.) has been continued ; including the study of the biology of certain species of *Calotermes*. The original colonies raised from eggs more than five years ago are still alive and flourishing.

Leucotermes ceylonicus was found in a dead tea bush. This species has similar habits to *Coptotermes* and has not previously been found attacking tea in Ceylon.

The treatment of *Calotermes* spp. in tea bushes by injecting Paris Green into the active termite galleries has been adopted extensively in the infested districts and records are now available regarding the treatment of considerably over one million bushes. The general consensus of opinion among superintendents of estates employing this treatment is that it is highly successful when properly applied. In no instance has there been any injury to the bushes and in some cases it is stated that there has been a definite improvement in treated fields.

The report of the Plant Pest Inspectorate, Southern Division, for the half-year January to June, 1932, states that the following species of bag worms were observed on tea during the period under review : *Clania variegata*, *Psyche albipes* and *Chalia doubledayi*. Tea tortrix (*Homona coffearia*) was reported from a few areas in the Division, and shot-hole borer from most tea estates. Red

borer (*Zeuzera coffeæ*) and termites (*Glyptotermes dilatatus*) were each reported in a single instance as attacking tea.

A few cases of the root diseases, *Botryodiplodia theobromæ* and *Ustulina zonata*, were reported, and *Pestalozzia theæ* (grey blight) and *Phoma theicola*, causing leaf-spotting of tea, were also reported from a few areas of the Division.

The following notes on pests and diseases of tea prevalent in the Central Division are contained in the report of the Plant Pest Inspectorate for that Division.

The area free from shot-hole borer (*Xyleborus fornicatus* Eich.) continues to be the well-defined area in the planting districts of Dimbulla, Dikoya and Maskeliya. This pest is found in all other districts, and its incidence varies with the district from almost negligible numbers of the insect to very severe attacks. The control of this pest is aimed at only in preventing its entry into the free areas. For this purpose regulations govern the transport of tea plants. These regulations have been revised this year so as to be very simple in operation, and enable free movement of plants in all parts of the island except into the free areas.

Increase of tea tortrix (*Homona coffearia* Nietn.) was noted in limited areas. The only control measure adopted and enforced is the collection and destruction of all stages of this pest, and all estates provide for this work in their yearly estimates. Quarterly returns of egg-masses collected are sent in to this office from all tea lands over ten acres. During the months January to March, 1932, the returns aggregated 34,790,722 egg-masses; 96·6 per cent. of the estates sent in returns, and 79 per cent. of them reported no tortrix.

The distribution of the tea termite (*Calotermes militaris* Desn.) has not shown much extension. Paris Green treatment is adopted.

Poria hypolateritia Berk. is a very common disease in the Division, and at times is responsible for the loss of many bushes. Several patches of the diseased plants may be seen on estates. Damage due to *Ustulina zonata* Lev., *Fomes lamaœnsis* Muir., and *Botryodiplodia theobromæ* Pat. is very limited.

CEREALS

Rice

Ceylon.—The following account of the work on rice is contained in the half-yearly report of the Division of Economic Botany for January to June, 1932.

An experiment is being carried out in conjunction with the Agricultural Chemist to study the effect of green manures on crop and soil and to observe the correlation between yield and soil reaction (see also p. 318). In the first stage of the experiment, conducted at Peradeniya during *maha* 1931–32, four treatments were adopted.

(1) Green manure at 1 ton per acre applied seven days before transplanting.
(2) Superphosphate at 1 cwt. per acre applied seven days before transplanting.
(3) Ammophos (11/45) at 96½ lb. per acre applied after final levelling.
(4) Superphosphate plus green manure at rates as above applied seven days before transplanting.

The control plots received no manure. Six replications were laid down, but one was discarded during the course of the experiment on the Chemist's instructions. The ordinary methods of cultivation were adopted and soil samples were taken before the first ploughing and at every stage of the subsequent operations. Further samples were taken at intervals during the growth of the crop.

The results, expressed as a percentage of the control, are as follows:

	Per cent.
Ammophos . .	159·75
Superphosphate plus G.M.	139·6
Superphosphate .	130·75
Green manure . .	115·1
Control . . .	100·0

The results are significant, and a copy has been sent to the Agricultural Chemist for comparison with his analyses. A full account of the experiment will be furnished in due course. The experiment is being continued during the *yala* season for observation of residual effect.

Hybridisation experiments with rice are in progress. These experiments are planned on a strictly utilitarian basis for the improvement of local strains; advantage is taken whenever possible of genetic results obtained by other workers and the characters required are being sought in local paddies and in a number of imported strains. The production of stiff-strawed white rices is receiving immediate attention.

The selection of salt-resistant and flood-resistant strains is also receiving attention. The problem is fundamentally one of irrigation, as the damage is done not so much by the actual flooding as by the stagnation of the flood water. As, however, major floods are not of regular

occurrence, it is felt that something may be done to develop resistant strains until such time as the irrigation problem can be tackled.

Experiments are in progress with implements for use in paddy cultivation. The Burmese harrow is becoming well known, and the department has now imported a hand huller from Malaya. This machine, which can be made by the village carpenter, will hull paddy more quickly and cheaply than the pestle and mortar now in use, and with no greater loss from broken rice. Models have been made locally and will be tried in the villages

Legumes

Nigeria.—Mr. J. West, of the Botanical Section, Southern Provinces, in a report for the first half year, 1932, states that the selection work with edible beans has been continued. Attention is now centred on the indigenous Popondos (*Phaseolus lunatus* forma *macrocarpus* Van Es.) and their hybrids. A supply of pure-line Popondo seed is produced each year, and to obtain this supply, selection is organised on a routine basis similar to that employed for cotton. A certain amount of out-pollination apparently takes place, thus making such a routine necessary. A Popondo selection is being tested out against *Mucuna aterrima* as a green manure in the plantation experiments. This selection is also being grown for the first time on observation plots at Benin, Onitsha and Umuahia agricultural stations. Small-scale experiments are under way to find the optimum time for sowing Popondo through early maize and yams.

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, has furnished the following report:

As stated in the previous report (this Bulletin, 1931, **29**, 326) the Madagascar beans are the most promising as an export crop, and a quantity of fresh seed has been imported from England for trial on a large scale this season. As regards fodder crops, the Amberique bean has again shown its ability to yield green fodder right at the end of the six months' dry season, but these results have been obtained only on really good land; sunn hemp has been found a very useful cover crop, but appears to be unpalatable to stock, either fresh or as silage.

Green gram (*Phaseolus radiatus*) introduced from Nyasaland in 1930 promises to be as useful a food crop for man and beast as it is in India. Small quantities of seed have already been issued to local farmers.

SUGAR

Cane

Leeward Islands.—*Antigua.*—The following report on investigational work carried out in Antigua during the period January–June, 1932, has been furnished:

The manurial experiments described in previous reports were reaped as plant canes during the period under review.

These experiments have been conducted at two stations and were designed for the purpose of investigating the effect of very heavy dressings of phosphate and potash in the presence of both high and low nitrogen.

There were eighteen different treatments and four replications of each treatment, the layout being randomised blocks.

At both stations there have been increases in the plots treated with phosphate and smaller increases in the case of potash and nitrogen. Owing possibly to the irregular stand referred to in the report for the period January–June, 1931, there has, however, been considerable variation in the yield between plots of the same treatment, and an examination of the results by the analysis of variance has shown significant differences only in the case of the phosphate treatments at Station A.

At this station the mean results for plots with no phosphate, plots with low phosphate (1,200 lb. superphosphate per acre), and plots with high phosphate (3,600 lb. superphosphate per acre) were 34·4 tons, 39·5 and 40 tons per acre respectively, the increases of 5·1 and 5·6 tons being statistically significant. It would therefore appear that under the conditions of the experiment the smaller application of phosphate would be the more economically suitable.

A spacing experiment has been started. At the time of planting exceptionally heavy rains were experienced, resulting, with the heavy soil of Greencastle Experiment Station, in poor germination due to "drowning" and necessitating a considerable amount of "supplying" which was carried out in drier weather. Germination counts were taken before each time of supplying and have afforded interesting figures as to the relative merits of flat and vertical planting as regards germination under wet and dry conditions. Under the former, flat planting gave readier germination; under the latter, vertical planting gave better germination.

St. Kitts-Nevis.—The investigation work undertaken

by the Agricultural Department, St. Kitts-Nevis, for the half-year ended June 30, 1932, was as follows:

The manurial and variety experiments on Molineux Estate were reaped.

The manurial trial with ratoon canes consisted of four randomised blocks and two 4 × 4 Latin squares. There were twenty different treatments and eighty plots. The canes were reaped as plant canes in March, 1931, the manures were applied in April, 1931, and the ratoon canes were reaped in May, 1932. The following quantities of fertilisers to the acre were chosen for comparison:

Blocks

(1) None.
(2) 40 lb. of Nitrogen as Sulphate of Ammonia.
(3) 80 lb. " " " " " "
(4) 120 lb. " " " " " "

These nitrogen treatments were repeated in combination with potash and phosphate singly and together (120 lb. potash as sulphate of potash and 40 lb. phosphate as superphosphate of lime). There were also four potash plots and four potash and phosphate plots.

Latin Squares

(Treatments given to plant canes, no treatment to ratoon canes.)

(1) No treatment.
(2) 12½ tons pen manure plus a mixture of artificials supplying 20 lb. nitrogen, 30 lb. potash and 20 lb. phosphate.
(3) 25 tons pen manure.
(4) 600 lb. Humber fish manure.

The results were examined statistically, using Fisher's Analysis of Variance and the following conclusions were drawn: On this area and under the conditions of the experiment a statistically significant difference has been found between the yields of first ratoons obtained from an application of 40 lb. of nitrogen per acre and applications of 80 lb. of nitrogen and 120 lb. of nitrogen per acre. Additional small increases in yield have been given by dressings of potash and phosphate, but the differences are not significant. The results indicate that a dressing of 80 lb. of nitrogen as sulphate of ammonia per acre was the most profitable application under the conditions of this trial.

The residual effect on yield of the pen manure and

pen manure plus artificials treatments is definitely significant. The application of fish manure gave no residual effect. When the costs of treatment are considered it is found that an application of 12½ tons of pen manure plus a small dressing of fertiliser salts is much more profitable than 25 tons of pen manure.

Manurial trials with ratoon canes were laid down on nine stations during the half year.

A variety experiment on Molineux Estate, which was planted in October, 1930, was reaped in February, 1932. This consisted of a trial with seven different varieties in a 7 × 7 Latin square. The results are summarised below:

Variety.	Cane. *tons per acre. Mean of 7 plots.*	Sucrose in juice. *lb. per acre.*	Sucrose in juice. *tons per acre.*
P.O.J. 2725	41·58	8,410	3·75
B. 381	38·77	8,400	3·75
B.H. 10. 12	38·40	8,100	3·61
S.C. 12. 4	37·23	8,240	3·67
B. 374	36·32	7,570	3·38
B. 417	35·51	7,810	3·49
B. 726	28·37	6,070	2·71

The significant difference between mean yields of any two varieties is 3·30 tons of cane per acre.

Fruits

Banana

Ceylon.—According to the report of the Mycological Division, Department of Agriculture, for the half-year ending June 30, 1932, work on Panama disease (*Fusarium cubense*) of plantains has been continued. Inoculation experiments have shown that even when plants are grown under favourable conditions infection by the fungus does take place, but that the progress of the disease under such conditions is slow. The relative susceptibility of the local varieties is under investigation but results are not yet to hand.

Citrus

Ceylon.—The Curator, Royal Botanic Gardens, Peradeniya, in his report for the half-year ending June 30, 1932, states that an improvement in the quality and numbers of budded citrus plants distributed locally is shown, and the budded stocks in present sites in nursery for comparison as to effect of stock on scion or vice versa continue to make growth, the largest being now 3 ft.

in height and well shaped. Observations made to date which may or may not be supported with further experience are as follows:

(1) The American or Cuban shaddock, whilst still the strongest and most robust of our stocks, is subject to severe attacks of citrus canker, but can be kept in check by sprays.

(2) The nataran (an apparent variety of the lemon or citron) requires great care on the transference of the budded plant from nursery bed to permanent site, otherwise it is subject to many losses. This may possibly be due to soil texture of the nursery, which is such that it does not encourage a good fibrous root system. In replanting the area where plants have been lifted, large quantities of coarse river sand are being incorporated which should remedy this considerably.

(3) Stocks in general at Peradeniya (1,550 ft.), if budded at the age of over 2 years, make considerably more headway after budding than stocks budded under that age. The bud growth of younger stocks appears to be heavily retarded by the cutting back of stock after budding, whilst the similar operation in the older plants has little effect and growth is subsequently rapid. It would appear that buddings on the older plants will reach maturity at an age that would more than compensate for the difference of time lost in waiting for the older stock. This may, however, not be so apparent at a lower elevation on more favourable soils, when growth of the seedling is more rapid than at Peradeniya.

(4) The inverted T system of budding for citrus appears the best method for Ceylon and the percentage of success on this system leaves little to be desired.

(5) The rough lemon common around Anuradhapura appears to be identical with the Cape rough lemon, the stock in general use in South Africa, and also used in Florida and Australia. Supplies of seed of this lemon have therefore been obtained and buddings will later be made on this for comparison with stocks already in use at Peradeniya and with our imported plants budded on to this stock.

(6) To date the American or Cuban shaddock, the nataran and the rough lemon have been propagated successfully by vegetative means in open beds. The sour orange and pumelo have been successfully rooted in the Solax propagator but not out of doors as yet.

The report of the Mycological Division, Department of Agriculture, for the half-year ending June 30, 1932, con-

tains the following notes on the investigation of citrus diseases carried out by Mr. W. C. Lester-Smith:

The discovery is announced of the presence in Ceylon of the citrus root nematode (*Tylenchulus semi-penetrans* Cobb); this is particularly noteworthy, and this eelworm has been recorded on the roots of all the common varieties of citrus, both on seedling trees and budded stocks. In almost every case it appears to be associated with citrus plants showing symptoms of leaf-mottle or "foliocellosis," which appears to be extremely common at both low and medium elevations (up to 4,000 ft.), and may prove to be the precursor of much of the "dieback" which citrus has suffered from for so long in Ceylon.

Citrus canker (*Pseudomonas citri* Hasse) appears to be widely distributed and common at all elevations up to about 3,000 ft. It does severe damage, more particularly in blemishing fruit, especially grapefruit, when no control methods to prevent its spread are adopted. It is extremely seasonal, depending mainly on weather conditions and injury by the citrus leaf-miner for its spread once infection is present. With the above-mentioned restriction in regard to altitude it is to be found on all citrus plantations of any size; isolated plantations and gardens the infection of which has been guarded against by natural or artificial means remain free of the disease. Where present it is essential that measures to prevent its spread by spraying should be carried out.

Mildew (*Oidium tingitaninum* Carter) is found quite commonly at low, medium and high elevations: it is readily controlled by spraying with a lime-sulphur solution and rarely does any damage if the plants receive proper attention.

Leeward Islands.—*Dominica.*—The investigational work which is being conducted by the Agricultural Department, Dominica, especially that in relation to efforts with the object of breeding a lime tree with high resistance to withertip disease and bearing fruits with properties identical with those of the West Indian lime, was fully reviewed by Mr. F. G. Harcourt in his report for the half-year ending December 31, 1931 (this BULLETIN, 1932, **30**, 209). In his report for the period January to June, 1932, he states that this work has been carried to a further stage by selecting eighteen of the original hybrids which are of proved high resistance to the disease and crossing them back, with the West Indian lime as male parent. The number of seedlings raised from these back crosses is recorded in the table below in which the female parent of

the original cross is first mentioned. Very little polyembryonic development was experienced, and with one or two exceptions the seed developed single seedlings.

Original crosses.	Number crossed back.	Seedlings raised.
Woglum Lime × West Indian . .	6	98
West Indian × Woglum Lime . .	5	12
Citrus aurantifolia × West Indian .	7	93
	18 parents.	203 seedlings.

Several of the original hybrids show particular promise and have been propagated for trial under estate conditions. Samples of ecuelled oil obtained from the Woglum lime and *Citrus aurantifolia* have been forwarded to the Imperial Institute for examination.

The sour orange stock, owing to its high resistance to root disease and storm, is the stock generally adopted for Dominica. For comparison as to fruit yields, etc., trials are being conducted at the Government Fruit Farm with oranges and grapefruit budded on rough lemon and grapefruit stocks. Similar trials are also being conducted with limes budded on these stocks at the Lime Experiment Station. It is too early to submit observations on these trials.

In order to assist planters and encourage greater diversification of industry, the propagation and distribution of various economic plants has been one of the principal activities of this Department during the last five years. During five-and-a-half years ending June 30, 1932, no fewer than 552,723 plants have been propagated and distributed, and include 122,655 coffee, 44,373 cocoa, 11,449 nutmeg, 67,967 budded limes and 11,965 budded grapefruit. A lively demand still exists for budded citrus and is being fully met.

Nigeria.—The following report from the Botanical Section, Southern Provinces, covering the period January to June, 1932, has been compiled by Mr. E. H. G. Smith.

A programme of citrus investigation has been commenced. There is a successful orchard of grapefruit and oranges on Moor Plantation, but the fruits, while esteemed locally, are not of the highest quality. It is proposed to make introductions of the best material available from the established fruit-producing countries for trial in Nigeria. The citrus experiments will be conducted at all suitable agricultural stations, thus, at the same time as the tests are progressing, the best citrus varieties will become

established at several centres in Nigeria. By the courtesy of the Director of Agriculture, Sierra Leone, budwood of several grapefruit, an orange and two lemon varieties has been received recently from that Colony. During the present year beds of citrus stocks are being established at Moor Plantation so that budding may go forward as new introductions are received.

A preliminary trial to test the suitability of several citrus stocks has been planted up this year at Moor Plantation, and has been reduplicated at Agege Experimental Station. Mr. J. R. V. Smyth, when Superintendent of Agriculture in charge of Moor Plantation, prepared the material. Two each of the best grapefruit and sweet orange trees in the Moor Plantation orchard were selected by Mr. Smyth as the scion parents, and eight different stocks were used, namely:

Sour Orange, *Citrus aurantium*.
Rough Lemon, *C. limonia*.
Seedling Sweet Orange, *C. sinensis*.
Seedling Grapefruit, *C. paradisi*.
Shaddock, *C. maxima*.
Acid Lime, *C. aurantifolia*.
Mandarine Orange } *C. nobilis* var. *deliciosa*.
Tangerine Orange }

Fisher's method of randomised blocks has been adopted for these trials, with the single tree as the experimental unit. One grapefruit and one orange scion are used at Ibadan, and the two others are planted at Agege. There are six replications of the stocks in each trial, both for grapefruit and for sweet orange, with the exception of the closely allied mandarine and tangerine stocks of which there are only three. A few non-experimental stocks budded with a Washington navel orange have also been planted. The spacing distances adopted are 27 ft. triangular at Ibadan, and 25 ft. square at Agege.

Tomatoes

Leeward Islands.—*Antigua.*—The following report covering the period ending June, 1932, has been furnished:

In October, 1931, a variety trial was planted with the following American varieties: Bonny Best, Marglobe, Jan Baer, Livingstone Globe and Walter Richards Globe.

The lay-out was a Latin square, each plot consisting of four 20 ft. banks, 4 ft. wide. The plants were set at 3 ft.

in the rows, unpruned and supported on brambles. All plots were mulched with cane trash.

The following table shows the actual yields of the individual plots in pounds and the mean yields in pounds, and calculated mean yields in pounds per acre and in short tons per acre:

Variety.	Actual plot yields.						Mean yields per acre.	
	Bed 1.	Bed 2.	Bed 3.	Bed 4.	Bed 5.	Mean.		
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*short tons.*
Bonny Best	59	75	68	58	55	63	8,560	4·28
Jan Baer	73	76	71	71	65	71	9,650	4·825
Livingstone Globe	63	61	72	68	45	62	8,430	4·215
Marglobe	34	45	41	41	33	39	5,300	2·65
Walter Richards Globe	49	59	51	50	47	51	6,930	3·465

The standard error of the experiment is 0·153 ton, so that differences between the means greater than 0·459 ton are significant. The best variety is Jan Baer; Bonny Best and Livingstone Globe are good varieties, while Marglobe and Walter Richards Globe are poor varieties of which Marglobe is the worst.

At each time of reaping, the fruits from the five plots of each individual variety were bulked and divided into three classes: good, poorly-shaped and damaged by insects. There was practically no damage due to fungoid disease, stem-end cracks or blossom-end rot on any of the varieties. No classification of the fruit for size was attempted, but as a general rule the fruit was small, the greater portion being of the " gem " size.

The following table shows the results of the classification followed:

Variety.	Good.	Discards.	Discards badly shaped.	Discards damaged by insects.
	Per cent.	*Per cent.*	*Per cent. of total discards.*	*Per cent. of total discards.*
Bonny Best	44·5	55·5	58	42
Jan Baer	56·6	43·4	50	50
Livingstone Globe	47·0	53·0	54	46
Marglobe	50·3	49·7	41	59
Walter Richards Globe	40·7	59·3	57	43

A qualitative varietal trial was planted with the following English varieties: Buckley, Potentate, Riverside Favourite, Everyday, Princess of Wales, Best of All, together with Teneriffe, Master Marglobe and a new Canadian variety Heterosis.

The following table shows the actual yields obtained and the calculated yields per acre.

Variety.	Actual yield.	Yield per acre.
	lb.	*lb.*
Buckley	95	17,190
Potentate. .	71	12,850
Riverside Favourite	74	13,390
Everyday. .	71	12,850
Princess of Wales	85	15,380
Best of All .	89	16,110
Teneriffe . .	69	12,490
Master Marglobe	-	1,450
Heterosis . .		8,690

Master Marglobe was planted rather later than the other varieties and proved a complete failure. The other varieties yielded well-shaped fruit, free from cracks and blemishes but as a rule too small for the Canadian market. Potentate was rather larger than the other varieties.

A *Staked versus Unstaked Experiment* was also carried out.

Three plots each 20 ft. by 40 ft. were planted under the variety Bonny Best, plants being set at 2 ft. in the rows, and staked and pruned to a single stem.

Three similar plots were planted under the same variety with plants set at 3 ft. in the rows, unpruned and supported on brambles.

Relative costs were kept for the two methods of cultivation and the cost per pound of fruit is shown together with the yields in the following table:

	Staked and pruned.			Unstaked and unpruned.		
Plot.	Actual yield.	Yield per acre.		Actual yield.	Yield per acre.	
	lb.	*lb.*	*short tons.*	*lb.*	*lb.*	*short tons.*
1 . .	200	10,800	5·4	150	8,100	4·050
2 . .	269	14,530	7·265	141	7,610	3·805
3 . .	231	12,470	6.235	108	5,830	2·915
Mean .	233	12,600	6·3	133	7,180	3·59
	Cost per lb. of fruit, 0·57*d.*			Cost per lb. of fruit, 0·75*d.*		

No classification was attempted with respect to size, but the fruit from the staked and pruned plot appeared to be of larger size.

The rainfall during the season under review was heavy.

October . .	7·02
November . .	7·81
December . .	9·34
January . .	2·78
	26·85 in.

It will be necessary to repeat this experiment under other climatic conditions and with increased replication of plots before definite results can be claimed.

St. Kitts-Nevis.—According to the report of the Agricultural Superintendent for the period January 1 to June 30, 1932, the following results were obtained from the spacing and variety trial with tomatoes. This was an experiment with four varieties of tomatoes planted at three different spacings. The layout consisted of four randomised blocks.

Variety Trial

Variety.	Mean yield of variety in short tons per acre.	Standard error of variety means.
Marglobe	3·43	
Livingstone Globe	4·19	0·236
Bonny Best	5·05	
John Baer	5·30	

Spacing Trial

Spacing.	Mean yield for spacing in short tons per acre.	Standard error of spacing means.
4 × 3 ft.	3·95	
4 × 2 ft.	4·96	0·205
3 × 2 ft.	4·57	

From analysis of variance it was found that there were significant differences in yield between varieties used and between the spacings used.

The following conclusions were drawn from the results: Bonny Best and John Baer are the highest yielding varieties, Livingstone Globe is a fair yielder and Marglobe is the worst yielder of the four.

The widest spacing, 4 ft. × 3 ft., has given a significantly lower yield than either of the other two. There is no proved difference between 4 ft. × 2 ft. and 3 ft. × 2 ft., but the closer spacing, 3 ft. × 2 ft., did not increase the yield.

The following is a summary of the results of the experiment carried out to ascertain the effect of cold storage on tomatoes packed for export:

Crate.	Treatment.	Ripe.	Turning.
		Per cent.	*Per cent.*
I	1 week in store, 50° F.	nil.	12·5
II	1 week in store, 4-hour exposure and another week in store	7·1	9·7
III	2 weeks in store, not exposed	4·2	13·8
IV	3 weeks in store, not exposed	13·3	33·3

Spices

Ginger

Ceylon.—According to the report of the Chemical Division, Department of Agriculture, for the half-year ending June 30, 1932, experiments were carried out, in co-operation with the Divisional Agricultural Officer, Central Provinces, to determine (*a*) the best method of curing ginger and turmeric; (*b*) the qualitative chemical changes taking place in the various curing processes in order to ascertain whether the latter were responsible for the poor quality of ginger in the local market; (*c*) whether the poor quality of the dried ginger was due to a poor raw product. The investigations indicated that (1) ordinary washing in cold water, scraping and drying in the sun, produced the best quality ginger; (2) boiling produced "black ginger" and resulted in a loss of some of the essential oil which is responsible for the odour of ginger; (3) Ceylon ginger has a lower essential oil and a much higher "resin" content than other gingers. This would account for the great pungency of local ginger.

At the request of the local Ginger Growers' Association samples of powdered ginger, ginger oil and essence of ginger were prepared from a sample of local ginger. The difficulties in the way of their preparation by the small grower were, however, indicated. A ginger manurial trial on modern field experiment lines has been laid down. The results will be statistically worked out on its completion.

Oil Seeds

Hydnocarpus

Uganda.—Mr. P. Chandler, Plantation Manager, Serere Experiment Station, reports that the ripening of the first crop of fruits of the two trees of *Hydnocarpus Wightiana*, now between eleven and twelve years old, was of rather long duration. The first fruits fell on October 16, 1931, and the last one was gathered on April 23, 1932. Sixteen fruits in all were harvested, these varying considerably both in size and the number of seeds. The latter ranged from four to twenty-six, the average number of seeds per fruit being twelve. The size of the largest fruit was 3 in. × 3¼ in. The seeds obtained from the fruits were sown in the nursery within two days of extraction from the fruits and by July seventy seedlings were on hand. Germination, however, was incomplete at that time and it seems to be quite normal for the seeds to take several

weeks to germinate under ordinary circumstances. With regard to the long period taken for the ripening of the first crop of fruits it may be of interest to mention that at the time there were three generations of fruits hanging and that since the original crop has been gathered the sequence is similar, a small new crop setting soon after.

Coconuts

Ceylon.—The report of the Plant Pest Inspectorate, Southern Division, for the half-year January–June, 1932, contains the following notes on the pests and diseases of coconuts prevalent in that Division during the period under review.

Black beetle (*Oryctes rhinoceros*) continues to be the commonest pest and has been reported from all coconut areas in the Division. Red Weevil (*Rhynchophorus ferrugineus*), though not as common as black beetle, has been reported from several areas. Only a single case of coconut caterpillar (*Nephantis serinopa*) was observed. Scale (*Aspidiotus destructor*) and mealy bugs (*Pseudococcus* spp.) were found attacking coconut leaves where the palms were growing under poor conditions of soil and cultivation.

Several cases of stem-bleeding disease (*Thielaviopsis paradoxa*) were observed, a few of them being in advanced stages.

According to the report of the Plant Pest Inspectorate, Central Division, black beetle (*Oryctes rhinoceros* L.) is present everywhere in that Division. Its direct damage is negligible, although very occasionally a small area shows bad attacks, due entirely to a supply of breeding places or to the practice of burying town refuse as manure. This beetle is, however, suspected of causing indirect damage by spreading "Bud Rot" disease. Red weevil (*Rhynchophorus ferrugineus* Fab.) assumed considerable importance during the period under review. It is found in all areas supporting young coconut palms. On two hilly estates, 93 palms were killed in six months over 900 acres. Stray palms killed by this weevil are common in villages and estates. Spotted locust (*Aularches miliaris* L.) is a rare pest in this Division.

Bud rot (*Phytophthora* sp.) has been prominent in certain coconut areas of the Central Division. One hundred palms of all ages have been killed by this disease on the two estates above mentioned. Stray cases occur on all large estates and more rarely on village gardens. Stem-bleeding disease (*Thielaviopsis paradoxa*) is a commonly occurring disease, but no noteworthy damage is done, except on young (sappy) palms.

Oil Palm

Nigeria.—The following report of the Botanical Section, Southern Provinces, covers the investigations carried out by Mr. E. H. G. Smith during the first half-year, 1932:

The planting up of the "Oil Palm Yield Test Blocks," referred to in the previous report (this BULLETIN, 1932, **30**, 215), has been proceeded with during the present rainy season. A further fourteen acres has recently been planted out, bringing the total area already established with Calabar oil palm selections to thirty-six acres. This area is divided between four experimental stations:

Moor Plantation, Ibadan
Ogba Farm, Benin City
Nkwele Farm, Onitsha
Umu-dike Farm, Umu-ahia

The supply of self-fertilised seed for native plantations has been continued, and, in addition, some two thousand special seedlings from the Ibadan nursery were distributed to native farmers in the area served by Benin Agricultural Station during June. The planting up of controlled crosses at one station only, Benin, has also been commenced.

Observations upon the leaf and flower production of the oil palm have been commenced at Benin and at Umuahia agricultural stations. About one hundred palms have been chosen for observation at each station. This number includes both young and fruiting palms, and examples of each of the six recognised local oil palm forms, together with Sumatran Deli palms. For young palms the date of the production of each new leaf is recorded. For fruiting palms the leaf date is similarly recorded, with the sex and date of anthesis of the inflorescence produced, and the date of ripening of the bunches produced by the female inflorescence.

Sesame

Nigeria.—The following report from the Botanical Section, Southern Provinces, relates to the investigations carried out by Mr. E. H. G. Smith:

A paper has been accepted for the 1932 *Annual Bulletin* of the Agricultural Department which describes the beniseed (sesame) investigation conducted during 1930. Samples of beniseed (*Sesamum indicum* Linn.) and a sample of *Sesamum radiatum* Schumach from the Benue Province were grown, and are described. The investigation was of importance on account of the black seed, with

which commercial shipments of beniseed to Europe have been found to be adulterated, and which lowers the oil content. No true black-seeded beniseed (*S. indicum*) was found. It seems probable that the so-called "black beniseed," which may be found in commercial parcels of beniseed, is usually *S. radiatum*, but it is possible that this term may be used for the black seed of *Ceratotheca sesamoides* Endl. *S. radiatum* is grown in the areas from which beniseed is exported. The most interesting seed samples studied were of commercial grades 2 and 3, of the three grades in which beniseed was said to have been purchased in the Gongola valley. These were found to consist mainly of *C. sesamoides*, with a proportion of what is judged to be a hybrid between *S. indicum* and *S. radiatum*, and, in grade 2 alone, a trace of *S. indicum*. Mr. D. Manlove, Agricultural Chemist, kindly determined the following oil contents of the seeds :

	Per cent.
Sesamum indicum	54·1
Sesamum radiatum	32·3
Ceratotheca sesamoides	37·3

There appears to be no reason why *C. sesamoides* should not be saleable in European markets provided the low oil content of the seed of this species can profitably bear the transport and other charges involved. Mr. Manlove's analyses show that the oil contents of shipments of beniseed containing an appreciable percentage of black seed, whether *S. radiatum* or *C. sesamoides*, would be considerably reduced.

Shea Nuts

Uganda.—In his report for the period January 1 to June 30, 1932, Mr. P. Chandler, Plantation Manager, Serere Experiment Station, states that in the case of shea nuts (*Butyrospermum Parkii*) a good stand of plants has been obtained from both seeds and seedlings planted during and since April of last year over an area of 7 to 7½ acres. A count made early in July of this year revealed only twenty-eight blanks in the rows from seeds and sixteen in the rows from seedlings. Progress is rather slow in both cases and rarely is a plant to be seen with more than seven leaves.

Other work being done with this particular tree during the period under review is the bringing of six adult trees under observation since the beginning of April, for such data as period of flowering, fruiting, leaf-fall, etc. These trees are scattered, and are practically the only trees in the immediate vicinity, the radius covered being between

500 and 600 yards. At the time of bringing the trees to notice, with one exception they were at the flowering period, this probably having been going on since December or January, but No. 6 tree did not come into flower fully till March. Some flowering, however, of this one must have taken place earlier, as an odd fruit or two were collected as early as April 6th.

Leafing was something similar, well advanced in all cases except No. 6, the leaves developing about the period of flowering or slightly after.

The average girth of the trees was 9 ft. at 4 ft. from the ground.

Other data since collected show that the duration of the fruiting period was from April 2 to June 25 (84 days) and the number of seeds per tree as follows:

No. 1 tree .	156 seeds.	No. 4 tree .	0 seeds.
,, 2 ,, .	87 ,,	,, 5 ,, .	506 ,,
,, 3 ,, .	157 ,,	,, 6 ,, .	33 ,,

These figures show an average of 156·5 seeds per tree, which is an extremely uneconomic yield when one considers that after twenty days' drying out from the date of collecting the last seeds, it took 89 seeds to weigh 1 lb. This number was obtained by counting the seeds of five separate samples of 1 lb. There were a number of double-seeded fruits encountered in the total yield, slightly under 15 per cent.

Two outstanding points which have been observed are that crop bearing is not an annual occurrence and that exact yields are very difficult to get on account of certain birds having a liking for the pericarp of the fruits, thus becoming a source of seed distribution. Such attacks are made soon after dawn, and on several occasions fruits with partially eaten pericarps, also showing fresh beak marks, were found anything up to seventy yards from the nearest tree at 6.30 a.m., this being one of those under observation.

Fibres

Cotton

Nigeria.—The following report from the Botanical Section, Southern Provinces, covers the investigations carried out by Mr. E. H. G. Smith during the first half-year 1932:

Cotton Yield.—Improved Ishan strain A gave what may be judged to be a bare average yield for Moor

Plantation during the past season (1931–32). The Moor Plantation cotton plots form one stage in the scheme of cotton multiplication, by which a quantity of pure seed is produced each year for distribution to native farmers. Cotton on this plantation is grown both as a sole crop, usually following an early green manure (*Mucuna aterrima*), or intercropped with yams, or with early, or late, maize. Thus, very varying plot and block yields are normally recorded each year, but the plantation average yield for the season over all plots is a fairly accurate indication of the relative yield. The average yields of Improved Ishan strain A in lb. of seed-cotton, compiled from figures supplied by the Superintendent of Agriculture, for the whole Moor Plantation cotton crop for the past three seasons are as follows :

	lb. per acre.
1929–30	545
1930–31	407
1931–32	378

Cotton Breeding.—The completion of the past cotton season has left little to be added to that recorded in the previous report (this BULLETIN, 1932, **30**, 217). The land used for the cotton selection plot proved to be in a rather low state of fertility, and equally poor yields were recorded for all strains. The elimination of roughness of lint from Ishan cotton remains the major problem, with present indications suggesting that no early solution may be obtained. It has been necessary to retain the Ishan hybrid strains in the single-plant stage for another season. Parent plants chosen for smoothness of lint are judged not to be yet producing an even degree of smoothness in their progeny. Five strains of New Guinea Kidney by Sea Island backcrosses, made by Mr. R. R. Anson, the Empire Cotton Growing Corporation's officer in Fiji, have been received for trial at Ibadan.

Mucuna and Cotton.—An experiment, consisting of a single plot of just under an acre, has been conducted with a view to testing the effect of growing a permanent rotation of early mucuna (*M. aterrima*) followed by cotton. The mucuna is sown in March with the first rains ; the previous cotton crop is uprooted and burnt early in April ; the mucuna is ridged in about the middle of June ; and the cotton crop is sown early in July. Thus the land is under continuous cropping and receives one ridging per annum. Improved Ishan strain A has been grown since the experiment commenced. Annual yields of seed-cotton are appended :

		lb. per acre.
1928–29.	Land cleared from bush	524
1929–30.	Early mucuna and cotton	807
1930–31.	,, ,, ,, ,,	431
1931–32.	,, ,, ,, ,,	411

This experiment is more in the nature of an observation plot, and as such provides useful information. No attempts have been made to assess the amount of cover crop turned in each year. An early season crop of mucuna grown as green manure appears to be adequately maintaining fertility for the annual cotton crop. The experiment commenced with two very favourable cotton seasons, especially 1929, which the early yields reflect.

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports as follows :

Strain L is now being substituted for Strain D which was found to be susceptible to jassids. L is not particularly hairy, but is not attacked by jassids to any great extent. In the yield trials of the last three years it has been found not inferior to the commercial Allen in yield. On good land its lint is worth 40 points more, but on poor land it loses the whole of this advantage. It seems doubtful whether the buying firms will be able to offer a steady premium for this strain, but by issuing it to farmers the danger of steady deterioration in quality of Northern Nigeria cotton will be averted. Several strains with high ginning percentage have been isolated, two of them 4 per cent. higher than commercial Allen and one of them 7 per cent. higher. Unfortunately the lint of the first two is slightly inferior and of the last one distinctly inferior to commercial Allen, and if anything all three yield less seed-cotton to the acre. They will be discarded.

A number of selections were made in 1930 and 1931 for yield. The testing of these will begin this season.

Selection work in the Kabba type has been continued, but there is little to report on this as yet. Several exotics have been tried and U4 seems promising at Yandev, Coimbatore 2 at Ilorin.

In 1930 there was an attack of jassids at the Empire Cotton Growing Corporation's farm at Daudawa and to a lesser extent elsewhere. Jassids appeared again in 1931, but though plentiful, did practically no damage at Daudawa even to the highly susceptible strain D which was grown there again on a twenty-acre block as a test of jassid attack.

Several new strains of U4 and two Uganda strains (S.G. 27 and S.G. 29) were grown for the first time in 1931. The two Uganda strains appear promising.

Rubber

Hevea

Ceylon.—According to the half-yearly report of the Experiment Station, Peradeniya, for January to June, 1932, an experiment for the purpose of comparing continuous alternate day tapping of all trees with alternate day tapping with one-third of the trees being rested in turn for a month at a time, was brought to a conclusion at the end of March. The yield from the one-third resting plots was in the four years of the experiment 10 per cent., 20 per cent., 11 per cent. and 31 per cent. less than that of the continuously tapped plots. Although the number of tappings was reduced by one-third, in no case did the yield fall by one-third, the average loss over four years being 17 per cent.

A manurial experiment finished its second year at the end of March. In the first year all three manurial treatments gave increases over the controls but the increases were not significant. In the second year all three treatments gave significant increases over the controls. The three treatments are:

(1) 2 lb. sulphate of ammonia per tree per year.
(2) 4 lb. sulphate of ammonia per tree per year.
(3) 2 lb. sulphate of ammonia, 2·2 lb. superphosphate and 0·8 lb. muriate of potash per tree per year.

The best results were obtained from the application of 2 lb. sulphate of ammonia. Doubling the dose appeared to have a depressing effect, while the addition of superphosphate or muriate of potash produced no increase of yield.

An experiment to compare yields from tapping a mixed block of budded rubber comprising twelve clones, at 1 ft., 3 ft. and 5 ft., was brought to a conclusion at the end of May. Taking the yield at 1 ft. as 100 the figures in the two years were as follows:

	1930–31.	1931–32.
5 ft.	59	64
3 ft.	81	107
1 ft.	100	100

It will be seen that in the first year the yields increased in proportion of the nearness of the cut to the base of the tree, as would be expected to occur in seedling rubber, though perhaps to a less extent. In the second year the situation was changed by the fact that the cuts at 1 ft. were approaching, or in some cases had actually crossed, the

union between stock and scion. This caused a marked reduction in yield from these cuts.

TOBACCO

Ceylon.—The report of the Mycological Division, Department of Agriculture, for the half-year ending June 30, 1932, contains the following notes on the investigation of tobacco diseases carried out by Mr. W. C. Lester-Smith.

Wilt (*Bacterium solanacearum* E. F. Smith) is the commonest and most important disease of tobacco and has been recorded during the period under review from almost every tobacco-growing district. There are some indications that, under the conditions of cultivation and manuring obtaining generally, the White Burley variety is more susceptible to the disease than local varieties.

"Frog-eye-spot," a leaf-spot caused by *Cercospora nicotianæ* Ell. and Ev., is also common, but is mainly confined to the basal leaves and has not been recorded as causing any serious loss.

A few cases of "mosaic," a virus disease, have occurred, but, unless the plants are affected in a young stage, there is little loss from this disease, as in most cases the leaf is not required for a high-grade tobacco, and diseased leaves which occasionally reduce the price are harvested and cured with the bulk of the crop.

One case of what is suspected to be "black-shank," caused by *Phytophthora nicotianæ* Rac., is under investigation, and some losses have been caused as a result of eelworm (*Heterodera marioni* (Cornu) Goodey) attack, both alone and in association with wilt disease (*B. solanacearum*). The importance of crop rotation, thorough cultivation and liberal manuring cannot be too strongly stressed in connection with tobacco cultivation.

DRUGS

Kola

Nigeria.—Mr. O. J. Voelcker, of the Botanical Section, Southern Provinces, in a report for the first half-year, 1932, states that individual tree yield recording with kola has been commenced at Ibadan, Benin and Umu-ahia. At Ibadan the trees have been in bearing for several years, but at the other two stations kola was not planted till 1924, and the 1931–32 season was the first to yield a crop. The following data from about 100 trees at each station are recorded: number of pods, weight of pods and number, colour and weight of nuts. The following points are

of interest: a small plot of kola planted from white nuts at Ibadan produced, during 1931–32, 485 white nuts, 36 pink and 147 dark pink or red; a similar plot planted from pink nuts gave 91 white, 2,450 pink and 84 dark pink or red; a block of 2½ acres of Abata kola planted in 1917 gave nothing at all, although flowering was heavy.

Experiments on root pruning, ring barking and open pruning on poor-bearing trees are being undertaken.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Acting Colonial Secretary the following report on mining in Cyprus during the six months ended June 30, 1932:

The world depression in trade continues to affect mining activities in the Colony, and further curtailment of operations has been necessary on the larger mines. At the end of April the Cyprus Mines Corporation, owing to a large accumulation of pyrites ore, decided to close down the Skouriotissa mine for at least six months.

The following statistics refer to the work done at the Skouriotissa pyrites mine of the Cyprus Mines Corporation:

	First 6 months 1932	First 6 months 1931.
Tonnage mined	50,667	75,751
Tonnage exported	50,477	79,240
Underground labour (average per day)	341	447
Total surface and underground labour (average per day) . . .	898	990

The following statistics refer to the development at the Mavrovouni pyrites mine of the Cyprus Mines Corporation:

	First 6 months 1932.	First 6 months 1931.
Boreholes, footage sunk . . .	nil.	382
Prospect drilling (underground) ft	355	3,850
Development, total footage .	6,889	1,919
Tonnage mined . . .	29,863	9,741
Tonnage exported . . .	17,868	8,519
Labour, underground only (average per day)	321	274
Total underground and surface labour (average per day) . . .	678	544

The following table refers to the work done at the Lymni mine of the Cyprus Sulphur & Copper Co. Ltd.:

		First 4 months 1932.	First 6 months 1931.
Underground development footage		209	56
Opencast, overburden removed, cub. yds.		26,042	18,736
Tonnage mined		1,094	363
Copper precipitate produced	*tons*	1	9
Average daily labour		64	78

The following statistics refer to the work done at the Troodos mines of the Cyprus Chrome Company Ltd. (Mining Lease and Prospecting Permit areas) :

	First 6 months 1932.	First 6 months 1931.
Development, total footage	237	nil.
Tonnage mined	nil.	nil.
Tonnage exported	nil.	nil.
Average daily labour	61	nil.

The following statistics refer to the output of the Cyprus & General Asbestos Co. Ltd. (formerly Cyprus Asbestos Co. Ltd.) Amiandos :

		First 6 months 1932.	First 6 months 1931.
Rock mined	*tons*	54,845	16,118
Rock treated	,,	12,056	2,659
Finished asbestos produced	,,	359	15
Finished asbestos exported	,,	767	2,049
Average daily labour (quarries only)		103	67
Average daily labour		212	217

Minerals exported, other than those dealt with above, were as follows :

		First 6 months 1932.	First 6 months 1931.
Terra umbra	*tons*	1,008	1,692
Terre verte	,,	9	16
Gypsum	,,	5,291	6,223
Building stone	*cub. yds.*	739	607

It will be observed that the figures previously given for the first six months of 1931 (see this BULLETIN, 1931, **29**, 341–2) have been amended in respect of the pyrites exported from the Mavrovouni mine and the output of building stone.

GOLD COAST

The Imperial Institute has received from the Director, Gold Coast Geological Survey, the following report on the research work on raw materials carried out by his department during the half year ended June 30, 1932 :

Field work included the detailed geological mapping of (*a*) the Birim diamond field and the surrounding country, (*b*) portions of the Akwapin and Volta River Districts, (*c*) the Akropong gold belt, and (*d*) the Tarkwaian System and the banket occurrences south-east of Kumasi. Reconnaissances were made in the area west and north-west of Prestea, in the vicinity of the Ofin and Pra rivers, and around Lake Bosumtwi.

More than 200 thin sections of the rocks from the Birim diamond field were examined by the Director and Dr. Cooper, and 120 concentrates were also examined. Most of the concentrates were studied by Dr. Cooper, but the minerals in some of them were determined by the Imperial Institute and by Dr. A. Brammall of the Royal School of Mines. Five rocks from the diamond field were analysed by the Imperial Institute. As a result of this work the conclusions stated in the report for the half-year ending June 30, 1931 (this BULLETIN, 1931, **29**, 344) may be supplemented as follows:

(*a*) The chief heavy-minerals in the concentrates are ilmenite, staurolite, rutile-quartz intergrowths, tourmaline, rutile and andalusite (?). A little magnetite, hæmatite, leucoxene and zircon are usually present. Among the rare minerals, besides gold and diamonds, are sphene, chrysoberyl (?), actinolite, tremolite, epidote, xenotime (?), kyanite, monazite, corundum and garnet. Beryl, cassiterite, anatase and brookite are very rare. The monazite, garnet and cassiterite are, with one or two exceptions, confined to the streams in the vicinity of the granite near Manso. The mineral believed by the Director to be chrysoberyl was found by him in four concentrates.

(*b*) Golden-brown rutile is regarded as an indicator of diamonds. It occurs in tremolite-rich ultrabasic igneous rocks between Kokotenten and Akwatia and has been recognised as an inclusion in one diamond.

(*c*) Near Akwatia, diamonds are said to have been found in pits sunk wholly in these metamorphosed ultrabasic rocks. Analyses of two similar rocks show that they are rich in magnesium silicates and that they contain 0·11 per cent. and 0·09 per cent. carbon, respectively. Artificial diamonds have been formed by dissolving carbon in fused olivine and in other magnesia and lime-rich silicates. This fact would appear to afford a ready explanation of the origin of the diamonds in the Birim diamond field.

The following is a brief summary of Mr. McGregor's conclusions regarding water supplies in the Akwapim and Volta River Districts :

(*a*) Deforestation of the Akwapim hills is one of the chief causes of water shortage.

(*b*) Every possible means should be adopted to conserve rain-water for use during the dry season.

(*c*) In certain localities increased supplies could be obtained by sinking wells to greater depths (30–70 ft.).

(*d*) On the plains south-east of Dodowa-Kpong road important supplies could probably be obtained by boring to depths of less than 200 ft.

(*e*) Certain villages in the Akwapim hills appear to be suitable for impounding water.

A large deposit of limestone was discovered by Mr. McGregor near Anyaboni, Volta River District. A sample of the limestone was analysed by the Imperial Institute, who report that it would be suitable, if finely ground, for agricultural purposes.

For a length of twenty miles alongside the motor-road from Akropong to Ayanfuri, Ankobra District, there are very numerous old workings on auriferous quartz reefs. The reefs are situated on approximately the same line as the Obuasi reefs and they appear to be connected with the same gold-channel. The persistence of the mineralisation and the results obtained from prospecting these reefs, lead one to believe that there is scope for the judicious expenditure of capital in exploring and developing them.

The Tarkwaian rocks, in the area south-west of Kumasi, occur in the form of a pitching overturned syncline dipping S.S.E. In the southern limb of the syncline the banket was traced more or less continuously from Banka to beyond Ntranang, a distance of eight and a half miles. Very fair prospects of gold were obtained from some of the banket in the old workings at Ntranang and Banka, but elsewhere it yielded only a little gold.

Another stretch of banket was traced for nine miles in a westerly direction from near Akoasi to beyond the Pra River. It yielded good prospects of gold at one place near Noyem, fair gold north-east of Bintempi, and fair to very poor gold in the vicinity of the Pra River. Only traces of gold were found in the banket in the north-westerly limb of the syncline.

Good gold prospects were obtained from reefs near Akokoaso and Kwae; from river gravels near Fureso,

Mirekro and Nkunsia, west and north of Prestea; in the valley of the Birim, south-east of Anyinam and in the area between Aberem, Ntranang and Noyem.

In the Western Akim and Birim Districts, isolated diamonds were discovered in thirty streams, where their existence was not known previously to the Geological Survey. Elsewhere, a few diamonds were found by the Director in streams north-east of the Ofin-Pra confluence, and a single stone by Mr. Lunn from an area south-west of Prestea.

NIGERIA

The Imperial Institute has received from the Director the following report of the geological work carried out by the Geological Survey of Nigeria during the six months ended June 30, 1932:

Gold.—The work of 1932 field season brings to a close the systematic survey of the area originally blocked out for investigation in 1927, lying between Lat. 9°30′N. and 11°30′N., and Long. 5°45′E. and 7°0′E., and covered by the seven Standard Sheets constructed by Royal Engineers and Survey Department during the last six years. The result of this survey will be published in due course.

Systematic work for the season included the survey of the uninhabited Kwiambana-Gusau Forest Reserve, certain parts of Kushaka Sheet, and the Kusheriki Sheet yet to be completed by ordnance survey. The geology of the areas continues the general structure of the field as revealed in former reports. Abundant evidence is available showing that the Nupe Sandstone series covered the whole area, and in the northern parts gneisses, schists and older granites are lost beneath relics of these rocks.

Mining.—The interest of the mining area is at present focussed on Kazai, about thirty miles east of Minna, where recently a 17 oz. nugget has been added to the 14 oz. and lesser nuggets previously reported from this area. Little or no valuation work has been done on this property, all activity being confined to constructive work for conservation of water for the next dry season.

On this property, a reef of very unusual composition was found, consisting almost wholly of garnet, chalcedony and opal in about equal proportions. The outcrop is about 1,000 yds. long by 100 ft. wide and is well exposed in the river Dinya and on both of its banks. The rock is no doubt the product of hydatogenesis.

If the sale of Kazai properties—about to be effected—matures, we may look for the first attack on the gold-field

with gravel pump and modern machinery. In the Minna area, a reef 2,000 ft. long, up to 5 ft. in thickness, and rising to 7 dwts. per ton has been proved.

Water Supply.—During the past half year, water-supply operations in the various Emirates have continued to meet with success, and it has now been demonstrated beyond doubt that the sedimentary beds of north-eastern and north-western Nigeria hold considerable bodies of water which can be tapped at reasonable depths. It was mentioned in the previous report that sub-artesian rises had been found in the north-eastern part of the Protectorate and further investigation shows that pressure rises are of much more common occurrence than was previously known. Later investigations go to show that they are to be regarded as the rule rather than the exception and can be exploited provided the flow of ground water is not too heavy to be controlled by the means at the disposal of the Department.

In central Bornu, geological investigations were continued to obtain further information regarding the Chad Basin in general and in particular that part of it marked out for development by wells next season. Owing to the scarcity of natural sections and the low dip of the beds, it is difficult to reach any definite conclusion, but such evidence as there is favours the presence of water under pressure at greater depths than have yet been reached by wells. While investigations will be resumed next dry season, it is probable that boring will be the only satisfactory method of proving any conclusions which may be advanced. The development of the north-western portion of Bornu Emirate by wells progresses satisfactorily and steadily. At Nguru, the terminus of the railway, additional shafts have been sunk, bringing the number up to sixteen, to meet the requirements of this rapidly growing centre. Between Nguru and the French border, a number of wells have been brought into production, or are in progress, which should assist materially in the opening up of this stretch of excellent grazing country. At the close of the present dry season, however, it is proposed to transfer operations to central Bornu where a big area of good grazing land awaits permanent supplies of water for its settlement and development. The number of shafts sunk to water in Bornu Emirate during the past half year is twenty-four.

In the adjoining Hadejia Emirate, shafts have been carried steadily westward along the Hadejia–Bornu boundary and south-westwards towards the railway at Kaugama. The presence of pressure water in this area also has now been demonstrated although owing to the heavy inflow of

ground water it is not always possible to reach it. The depth to ground water varies from 125–150 ft. and is remarkably constant. Arrangements are being made to extend operations to the neighbouring Emirate of Gumel in the coming dry season.

In Sokoto Emirate, a scheme based on the daily yield obtained from the 9-ft. diameter experimental shaft has been put forward to give the city an adequate and permanent supply of water. Work will be spread out over a period of years while at the same time investigations for the development of other potential and additional sources of supply are being continued. Furthermore it is considered important that there should be no serious curtailment of well-sinking in the arid bush areas. The completion of the chain of wells in the waterless area traversed by the motor road from railhead at Gusau has already resulted in the formation of several settlements and in the use of this route by ordinary wayfarers and travellers.

UGANDA

The Imperial Institute has received the following report from the Director of the Geological Survey of Uganda regarding the work carried out during the half year ended June 30, 1932.

Mr. E. J. Wayland returned from home leave on January 20, and in February went down the Nile from Lake Albert to Laropi with the members of the Lake Albert dam expedition, investigating possible dam sites. He went, in April, to the Kilembe Copper Mine and later visited the Kakamega gold-field in Kenya Colony where the mode of occurrence of the veins yielding the alluvial gold was studied.

Mr. A. D. Combe has spent the whole time in the Kigezi and Ankole districts. In Kigezi, the gold deposits in the "Impenetrable forest" were investigated. Up to the end of June this year, a total of 329 oz. of unrefined gold was sent to London by the holders of the concession, making a total of nearly 400 oz. since prospecting operations started. The gold was found to occur generally as coarse, unworn grains in the alluvial deposits of the narrow stream beds, and the proportion of fine gold is small. Prospecting is actively proceeding in this difficult country, and up to June 30 the veins yielding the gold had not been located.

In Ankole, Mr. Combe has been making rapid geological reconnaissances and prospecting in an area which consists largely of Karagwe-Ankolean rocks intruded by granites, where he has got some encouraging results for gold but not

yet for tin. Incidentally he investigated some of the volcanic tuff deposits south of Lake George and sent in many beautifully preserved fossil leaves.

Mr. Simmons has spent all his time in the laboratory and has made a special investigation of Mwirasando tin ores. The Memoir on the "Geology of south-west Ankole and adjacent territories with special reference to the tin deposits" by Mr. A. D. Combe and Dr. A. W. Groves was seen though the press and is now available.

During the half year much laboratory work has been done in assaying, testing and analysing specimens sent in by the public and officers in the field, and the number of fire assays for gold was considerably in excess of any previous similar period. Cheap lime is still one of the needs of the Protectorate and several analyses of specimens sent in have been made.

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Tanning Materials

Su alcuni vegetali concianti della Somalia Italiana e dell'oltre Giuba. By G. A. Bravo. *Boll. R. Stazione Sperimentale per l'Industria delle Pelli e delle Materie Concianti* (1932, **1**, 189–198). Notes on tannin plants of Italian Somaliland.

Zur Charakteristik des Katechu, Gambir und Kino. By H. Freytag. *Collegium* (1932, **6**, 506–511). Chemical studies of catechu, gambier and kino.

Tannin Data on Hairy Chinese Chestnut Trees Grown in the United States. By I. D. Clarke and R. W. Frey. *Journ. Amer. Leather Chem. Assoc.* (1932, **27**, 206–215).

The Production of Tannin Extract from the Kino-impregnated Bark of Marri (*Eucalyptus calophylla*). By W. E. Cohen. *Journ. Counc. Sci. Indust. Res., Australia* (1932, **5**, 110–122).

Mangueblätter und Mangueextrakt. By W. Vogel. *Collegium* (1932, **6**, 31–42). An account of mangrove leaves and extract, their composition and use.

Contribution Analytique à l'Étude Chimique des Écorces de Palétuviers des Colonies Portugaises. By J. C. da Silveira. Pp. 118, 10½ × 7½. (Lisbon: 1932.) Extract from *Anais do Instituto Superior de Agronomia*, vol. v, No. 1. Analytical study of mangrove barks of the Portuguese Colonies.

Annual Report of the Committee of the Natal Wattle and Timber Growers' Association. Pp. 3, 13¼ × 8¼. (Maritzburg: Wattle and Timber Growers' Association, 1932.)

The Growing of Wattle and Production of Wattle Bark in Kenya. By W. G. Leckie. *Bull. No.* 1 *of* 1932, *Dept. Agric., Kenya.* Pp. 45, 9¾ × 6¼. (Nairobi: Government Printer, 1932.) Price 50 cents.

Notes on Wattle Barks. Part III. By M. B. Welch, F. A. Coombs and W. McGlynn. *Journ. and Proc. Roy. Soc., N.S. Wales* (1932, **65**, 207–231).

An Undescribed Species of Wattle. *Acacia filicifolia.* By E. Cheel and M. B. Welch. *Journ. and Proc. Roy. Soc., N.S. Wales* (1932, **65**, 232–234).

The Determination of the Tannins of Wattle Bark. By R. O. Page and H. C. Holland. *Journ. Amer. Leather Chem. Assoc.* (1932, **27**, 163–174).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

HANDBOOK OF COMMERCIAL GEOGRAPHY. By Geo. G. Chisholm, M.A., B.Sc., Hon.LL.D. Twelfth Edition, revised and edited by L. Dudley Stamp, B.Sc., B.A. Pp. xv + 825, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1932.) Price 25*s.*

In the notice of the ninth edition of this Handbook which appeared in this BULLETIN (1922, **20**, 416), regret was expressed that a work of such general utility had not been submitted to more complete and careful revision, especially in the sections dealing with economic products. The particular inaccuracies then instanced have been largely corrected in the present issue, but many misleading statements still occur and the need for general revision is as manifest as before.

A lack of balance is noticeable in the space devoted to various subjects; thus, 20 pages each are devoted to the regional sections on Canada and China, but only 17 to India and 11 to South America, and only 25 to the United States, despite the immense importance of the last-named country in world commerce. The printing of the volume is characterised by an extraordinary mixture of types, resulting from repeated piecemeal revision of the work and detracting considerably from the appearance of its pages. For this reason alone it may be hoped that for the next issue, which the editor does not consider likely to appear for several years, the book will be re-set throughout; and in view of the drastic re-writing of many portions which will be necessary if the edition is to be fully up-to-date, this course appears unavoidable. A complete, careful re-consideration of each chapter and each paragraph of the volume should in the meantime be made, the contents more satisfactorily co-ordinated, and all technical matter submitted to experts for detailed criticism, so that the edition may be thoroughly reliable and the Handbook, to use the editor's words, rendered "of still greater service."

EMPIRE STOCK-TAKING, 1932. AN ABRIDGED REVISION OF "EMPIRE STOCK-TAKING, 1930." By L. St. Clare Grondona. Pp. 84, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Haycock Press, Ltd., 1932.) Price 3*s.* 6*d.*

The first edition of this useful work was noticed fully in this BULLETIN (1930, **28**, 393), and little therefore

need be said regarding the smaller supplement which is planned on similar lines. It consists principally of statistical tables compiled from official publications issued since the earlier edition appeared, together with brief comments on the outstanding facts regarding the present position of the trade between the United Kingdom and the rest of the British Empire in the principal raw materials and manufactures. In the case of each product and subject dealt with, references are given to the more detailed commentaries in the 1930 edition, the price of which has now been reduced from 10*s*. 6*d*. to 6*s*. 6*d*.

The difficult task of condensing a vast variety of data into a concise and convenient form has again been done well, but there is considerable risk that summaries of this character may be misleading, owing to the impossibility of including the explanations and qualifications necessary for those readers who have not a detailed knowledge of the subject. The value of the comparisons between the domestic exports of raw materials from the Overseas Empire and the total imports of such materials into the United Kingdom would be enhanced by including, in a number of cases, statistics of the imports into the whole of the British Empire. For those products for which the United Kingdom has a large re-export trade, figures showing the imports retained as well as the total imports would be of interest. The small table of the exports of certain ores does not give any real indication of the relation between the Empire's mineral resources and requirements, and more space should be devoted to this important question.

PIONEER SETTLEMENT. Co-operative Studies by twenty-six Authors. Pp. vi + 473, $10 \times 6\frac{3}{4}$. (New York: American Geographical Society, 1932.)

A reference to this symposium was made in this BULLETIN (1932, **30**, 97) in the notice published of the introductory volume, entitled "The Pioneer Fringe." It is stated in the preface that the present work "constitutes a world survey of pioneer problems by specialists who have an intimate personal knowledge of the regions they discuss"; this renders the contents of enhanced value, whilst additional interest is afforded by the insertion at the end of the book of biographical notes on the authors in question, who are of several nationalities.

The regions dealt with in the articles include Canada, United States, parts of South America, the Union of South Africa, North Africa (Algeria, Tunis and Morocco), Rhodesia, Nyasaland, Siberia, Mongolia, Manchuria, Australia and New Zealand, the whole forming a highly

instructive series of monographs on the conditions of land settlement and development in the areas concerned.

An Atlas of the Progress in Nawanagar State Accomplished since the Accession in March 1907 of Lieutenant-Colonel His Highness Shri Sir Ranjitsinhji Vibhaji Maharaja Jam Saheb of Nawanagar, G.C.S.I., G.B.E. By John de la Valette. Pp. v + 30, and 21 Charts, 11 × $8\frac{3}{4}$. (London: East & West, Ltd.) Price 10*s.* 6*d.*

This publication is a descriptive handbook rather than an atlas, the maps being of a diagrammatic type and illustrating communications, industries, irrigation works, etc., whilst there are also a number of full-page statistical charts in colour, and a well-written account of the progress of the State in recent years. The book furnishes an excellent presentation of its subject.

Daughters of Africa. By G. A. Gollock. Pp. xiv + 175, $7\frac{1}{2}$ × 5. (London, New York, Toronto: Longmans, Green & Co., 1932.) Price 3*s.* 6*d.*

This work consists of a collection of short stories of African women compiled for the edification and instruction of young Africans who are just stepping out into life after leaving school or college. The stories are true and in most cases are told with the object of inculcating the Christian virtues. As a sample of the fare provided, the following may be quoted from the preface, where it is printed as a " small foretaste."

" A month's ' refresher course ' was being held at San Salvador in the Portuguese Congo. Some sixty African teachers and twenty of their wives came in from the surrounding districts. Several of the wives shared in the lectures given to the men. One day the subject of how to teach arithmetic was under discussion. The lecturer began: ' If the Portuguese school inspector appeared suddenly in your schoolroom and bade you give an arithmetic lesson in his presence, what would you do? ' There was silence for a moment. Then an African teacher spoke, ' I would call my wife,' he said."

Farm Management in South Africa. By E. Sewell Dawson, Farm Manager, Experiment Farm, University of Pretoria. Pp. 338, $8\frac{1}{2}$ × $5\frac{1}{2}$. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1931.) Price 22*s.* 6*d.*

The author of this volume points out in his Preface that farming in South Africa is passing through a transition

period urgently necessitating improvement in methods, and that he has written the book " in the hope that it will afford enlightenment on the problems of organisation and management confronting farmers, particularly novices, and that it will give an impetus to the improvement of farming methods."

The volume should go a long way towards carrying out this object, the more so as it is written in a concise and lucid style. An indication of the wide scope of its contents may be given by quoting the following titles of certain of the chapters: Functions of Management; Capital and its Uses; Taking up a Farm; The Tractor Question; Management of Pasture and Soils; Live-stock; Marketing and Co-operation; Records and Accounts. The subjects are presented with the aid of much excellent illustrative detail, and some useful photographs of equipment and operations at the Experiment Farm of Pretoria University are also furnished.

As implied by the title the work is primarily intended for present and prospective farmers in South Africa, and due regard is accordingly paid by the author to local conditions. The treatise is, however, concerned so largely with general principles and information of a fundamental kind, that it can be strongly recommended also to readers outside the Union who desire guidance in the conduct of farming operations.

CACAO. By Dr. C. J. J. van Hall. Pp. xviii + 514, $8\frac{1}{2} \times 5\frac{1}{2}$. Second Edition. (London: Macmillan & Co., Ltd., 1932.) Price 28*s*.

In the review (this BULLETIN, 1915, **13**, 177–178) of the first edition of this book, it was stated that it " has been eagerly awaited by tropical agriculturists and its appearance fully justifies the expectations held regarding it." During the period which has elapsed Dr. van Hall's work has been the standard book on the cultivation and preparation of cocoa, a position which, in its revised form, it will undoubtedly maintain.

To those familiar with the original edition it will be sufficient to note that the form and arrangement of the book have been but little changed. History, geographical distribution, climatic conditions, soils, chemistry, botanical questions, cultivation, preparation, diseases and pests are well dealt with in the light of modern knowledge, and followed by an account of the industry in the countries of production, with a summary of information on marketing. In the chapter on cultivation, Dr. van Hall treats the

vexed questions of spacing, shade and manuring on broad biological lines, and indicates that now, as nearly two decades ago, there is no " best " method applicable to all cases, but that cultural practices are determined by local conditions. Even on fermentation, to which considerable attention has been devoted, he says that " no practical success of real importance has been obtained with the various efforts to improve the empiric methods."

There is, however, the one entirely new chapter, that on Selection, to indicate a definite advance made since the issue of the first edition. As the outcome of work, mainly in Java and Trinidad (see this BULLETIN, 1929, **27**, 461–469) it has been shown that cocoa trees vary naturally in yield, and that selection and propagation of heavy bearing strains is practicable. Definite means are thus now available both to form new estates of good yielding strains, and to replace the large proportion of poor bearers which the Trinidad investigations have shown to occur on most estates.

Enough has been said perhaps to make it clear that this new edition is a book which should be carefully studied by all progressive cocoa planters.

VEGETABLE FATS AND OILS. By George S. Jamieson, Ph.D. Pp. 444, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1932.) Price $6.50.

This volume forms one of the series of monographs on chemical subjects in course of publication by the American Chemical Society. Within its pages the author has included as much information as possible in regard to vegetable oils and fats and has added greatly to the value of the monograph by giving a list of references to original papers and articles. By this means readers are enabled to obtain more detailed information than could conveniently be incorporated in the book.

The main portion is devoted to an account of the sources, preparation, uses and analytical data of vegetable oils and fats. In the list are included all the oils of technical importance and many of those which at present are not used to any extent, if at all, in commerce. In common with other textbooks on this subject, these materials are divided into non-drying, semi-drying and drying oils.

In the opening chapter a brief but thoroughly comprehensive summary is given of the methods of preparation and refining of oils. Fuller descriptions of these processes appear in the section devoted to the consideration of the

individual raw materials ; for instance, refining technique is dealt with especially in the case of cotton-seed oil, linseed oil and olive oil ; hydrogenation is included in the section on cotton-seed oil.

Another chapter is allocated to a description of methods of analysis and detection and, with few exceptions, only one standard process for each determination or test is given. Although some readers might prefer to have more alternatives included, yet those mentioned present the advantage of having in nearly all cases been critically examined in the author's laboratory.

Brief accounts of the fatty acids, glycerol, sterols and other constituents of oils are given in Chapter V. Two indexes, one of botanical names and the other of subjects, are included.

The monograph can be thoroughly recommended and will be valued by those engaged in the industries concerned. It may be mentioned that more careful proof-reading would have been advantageous.

A Study of Empire Wool Production. Being a Survey of Conditions in New Zealand, Australia, South Africa, Southern Rhodesia, Kenya, Canada, Irish Free State, etc. By J. E. Nichols. Pp. 148, $9\frac{3}{4} \times 6\frac{1}{4}$. (Leeds: Wool Industries Research Association, 1932.) Price 5*s*.

During the years 1928–1931 the author carried out a survey of the principal wool-producing areas of the Empire outside Great Britain with the object of studying the various factors which influence the rationale of production. The tour was undertaken on behalf of the Wool Industries Research Association, and the expenses were defrayed by the Empire Marketing Board. The present work is a record of some of the facts learned and conditions encountered which appear to be of special importance to the wool industry.

The book consists of three parts. Part I is of a general character and deals with the economic products derived from the sheep, the pastoral and agricultural conditions and the altitude and rainfall required for the maintenance of the flocks, the difference in fertility which exists between breeds and between the same breeds in different habitats, the carrying capacity of different areas, the characters and quality of wools of different types, and wool classing.

In Part II an account is given of the present position of the sheep and wool industry in different parts of the Empire, the countries being considered in the following order: New Zealand, Australia, South Africa, Southern

Rhodesia, Kenya, Canada, Irish Free State, Palestine. Estimates are also given of the sheep population and wool production in other Empire countries, viz. Cyprus, Falkland Islands, India, 'Iraq, Newfoundland, South-West Africa, and the United Kingdom, and notes are added regarding producers' organisations and the position of education and research in the wool-growing countries.

In Part III the author discusses the problem of wool improvement in the light of the experience gained during his Empire tour, and he suggests that for solution of the general problems from the producers' point of view the following are required :

" 1. A study of wool supplies, including consideration of (*a*) the relationships of sheep types in the general organisation of the industry in each country and trends of production ; (*b*) the most suitable environments for given types of sheep ; (*c*) the bulks contributed by individual animals to the whole supply.

" 2. Investigation of specific defects of the different types of wool from the manufacturers' point of view and of the desired wools in relation to the welfare of the animal (the former line of investigation is being pursued in the laboratories of the Wool Industries Research Association).

" 3. Enquiry into the best means whereby the breeder may recognise characteristics which are undesirable in manufacture.

" 4. Examination of the possibility of eradicating or reducing the undesirable features or of influencing, by selection and husbandry, the kind of wool produced by a given type of sheep.

" 5. Research into the economic conditions which affect or limit the possibilities of including in practical sheep husbandry the results of any of the above."

The book, which is written in an interesting manner and illustrated with 25 photographs, will serve an important purpose in affording authentic information on wool-growing in Empire countries.

THE FREEZING, STORAGE AND TRANSPORT OF NEW ZEALAND LAMB. By Ezer Griffiths, D.Sc., F.R.S., J. R. Vickery, M.Sc., Ph.D., and N. E. Holmes, B.E.E. Department of Scientific and Industrial Research, Food Investigation, Special Report No. 41. Pp. x + 178, 9½ × 6. (London : His Majesty's Stationery Office, 1932.) Price 7*s*. 6*d*.

This Report embodies the results of an investigation lasting four months carried out by a number of scientific

workers under the auspices of the Department of Scientific and Industrial Research with the co-operation of various other bodies.

The work consisted of a comprehensive study of the conditions surrounding carcases at every stage from the abattoir in New Zealand to the wholesale markets in Great Britain, with special regard to their effect on the quality of the meat ultimately reaching the markets.

The factor principally concerned is that of "bloom." This is a particular appearance of the carcase that is considered by purchasers to be associated with "freshness," and therefore affects prices, whatever it may or may not represent in true value. More precisely, meat with good bloom is worth about a halfpenny per pound more than meat with inferior bloom.

Associated with the question of bloom is that of loss of weight by evaporation of moisture or by "sweating" in cold storage. It is stated that if this loss in weight could be reduced by one quarter the industry would gain £100,000 in a normal season.

Another consideration, not merely æsthetic but also translatable into cash, is the distortion of carcases under load.

The relative advantages of different systems of refrigeration were investigated, and a number of matters of procedure and practice, for instance in transporting carcases between the docks and the cold store, are dealt with in the Report. The technique of freezing as affecting "drip" or loss of fluid on thawing is also considered.

Impairment of bloom has been found to be produced by an increase in the opacity of the superficial tissues of the carcase due to loss of moisture, and in some cases by oxidation of the red hæmoglobin of the muscle to methæmoglobin. These changes are prevented or reduced by not allowing the carcases to sweat, and by observing certain conditions of temperature and humidity in storage.

The general outcome of the investigation is that no radical departure from established methods is necessary, but that at every stage there are points of technique to be observed. The suggestion is made that in order to minimise evaporation and sweating, wrappings of a less permeable nature than the customary stockinette should be used. Experiments carried out during the survey with materials of low permeability gave satisfactory results, and the employment of such materials becomes a question of balancing the additional expense involved against the increased value due to improved appearance and diminished loss of weight.

It is pointed out that ante-mortem influences, such as breed, age and diet, may also be factors in determining the qualities of the carcase reaching the markets. Such study of this part of the question as has already been made points to a Southdown cross as giving a satisfactory carcase having good bloom, but further investigation is necessary.

DIRECTORY OF PAPER MAKERS OF GREAT BRITAIN AND IRELAND FOR 1932. Pp. 261, $10\frac{1}{4} \times 7\frac{1}{4}$. (London: Marchant Singer & Co., 1932.) Price 5*s*.

This useful annual publication, which has now appeared for fifty-six years, contains lists of manufacturers, and of paper-makers' representatives and paper agents; names of wholesale stationers in London; lists of mills, makes of paper, watermarks and trade names; sizes of papers, and other relevant information. The book is a concise and practical work of reference for the paper trade as a whole.

EXOTIC FOREST TREES IN THE BRITISH EMPIRE. By R. S. Troup, C.I.E., D.Sc., F.R.S. Pp. viii + 259, $9\frac{1}{2} \times 6\frac{1}{4}$. (Oxford: The Clarendon Press, 1932.) Price 20*s*.

This book appears as a result of a decision of the Third British Empire Forestry Conference (1928) to invite the Imperial Forestry Institute, Oxford, to undertake the task of compiling and publishing the mass of information submitted to the Conference regarding the introduction of exotic forest trees into the different countries of the Empire, and to collect such further information on the subject as appeared necessary.

This extensive task has been completed by Professor Troup and a very useful work on a subject which has suffered from the drawbacks of a widely scattered literature is now available. The main object has been to summarise the results of experience gained in planting exotic forest trees in different parts of the Empire. Two difficulties naturally arose in dealing with the subject, namely, to decide as to the amount of information to be given without extending the book beyond reasonable limits, and as to which species to include and which to omit. The methods adopted appear to be satisfactory and successful. A useful summary for each species is given while further information is indicated in a bibliography for that species. The decision to include only those trees which have been tried for plantation purposes, either for timber or for any other purpose, has prevented undue extension of the book.

An introduction discusses the importance of exotic

trees and the climatic, soil and other factors which govern their successful cultivation in new countries. The descriptive account of the list of species dealt with occupies some 222 pages and is followed by a general bibliography and two illustrated appendixes dealing with the climate of Australia and the climate of South Africa respectively.

SOME EAST AFRICAN CONIFERÆ AND LEGUMINOSÆ. By L. Chalk, M.A., D.Phil., J. Burtt Davy, M.A., Ph.D., and H. E. Desch, B.Sc., M.A. Pp. 68, 9½ × 6. (Oxford: The Clarendon Press, 1932.) Price 5*s*.

The series of which this is the first number promises to be a valuable addition to the growing literature dealing with Empire woods and the trees yielding them. The forester overseas will in time have available a descriptive handbook of important timber-yielding species containing a technical account of the woods themselves, while the wood technologist will have brought before him an idea of the tree and its essential botanical features—an aspect of timber study too often neglected, largely as a result of the difficulty of ready access to the requisite information.

In the present publication (which has a preface by Professor R. S. Troup) the authors deal with a group of African coniferous and leguminous trees which have become well known as yielding interesting woods. These include the African pencil cedar (*Juniperus procera* Hochst.), Mlanje cypress (*Widdringtonia Whytei* Rendle), the two " podos " or yellow-woods (*Podocarpus gracilior* Pilger and *P. milanjianus* Rendle), Rhodesian or pod mahogany (*Afzelia quanzensis* Welw.), Rhodesian teak (*Baikiæa plurijuga* Harms.), Rhodesian mahogany (*Copaifera coleosperma* Benth.), Mopaane (*C. mopane* Kirk), two Piptadenia species (*P. buchananii* Baker and *P. africana* Hook. f.), mlombwa or kajatenhout (*Pterocarpus angolensis* DC.) and Mwangura (*Pterocarpus stevensonii* Burtt Davy), a recently described species from Northern Rhodesia.

Each description gives in detail the common, vernacular and botanical names of the tree, followed by a botanical description containing much valuable information and including a key to the African species of the genus concerned, a feature that will be much appreciated by forest officers; where feasible a synopsis of the species is also given. The description of the timber is recorded under the headings of general properties, macroscopic and microscopic features. The sections are illustrated by a habit photograph of the tree, photomicrographs of the timber

and line drawings of botanical characters. The format and production of the book are most pleasing.

The Trees of Yosemite. A Popular Account by Mary Curry Tresidder, with 34 Linoleum Block Prints by Della Taylor Hoss. Pp. xiv + 133, 10 × 7. (California: Stanford University Press; London: Humphrey Milford, Oxford University Press, 1932.) Price 11*s.* 6*d.*

This is a very attractive book on the trees of the Yosemite National Park, the most famous of which are the Giant Sequoias. Each species is illustrated by a silhouette of a mature tree or a study of a branch bearing foliage and fruit, the latter frequently cones. These delightful drawings would in most cases enable the identity of a tree met with to be determined. In addition there are useful charts setting out in tabular form classifications of the trees according to their characters in a broad sense (i.e. not merely purely botanical), and to their zones of occurrence in the region. The notes accompanying each species include popular descriptions of habit and other characters, indications of localities where seen to advantage, and other information of general interest.

The book would be of special interest to a traveller whilst in the Yosemite, and as an artistic and informative souvenir of such a visit.

Fertilisers and Food Production on Arable and Grass Land. By Sir Frederick Keeble, C.B.E., Sc.D., F.R.S. Pp. ix + 196, 7¼ × 5. (London: Humphrey Milford, Oxford University Press, 1932.) Price 5*s.*

To quote the author's opening sentence: "The aim of this book is to show that a large increase of home-grown food can be brought about—and brought about quickly—by the use of fertilisers." Tracing the history of British agriculture since 1868 it is shown that the wheat acreage has been reduced by one-half, barley and roots and green crops by more than one-third; pastures have largely increased in area but with little if any increase in the number of live-stock they carry. These changes are attributed to the great production of cheap supplies of wheat and live-stock from the virgin areas of the world, coupled with the fact that when the farmer was forced to reduce his arable acreage knowledge was not available to show him how the productivity of grass-land could be increased so as to compensate for the loss of plough-land.

The need for fertilisers in cultivating arable crops is well known. The results of experimental work, mainly at

Jealott's Hill and on associated representative farms in various parts of the country, are summarised to show that considerable crop increases could be obtained by the more liberal use of fertilisers than is customary. In many areas drainage and liming require much attention to enable the best results to be obtained.

The manuring of pasture land is a much newer subject. It is shown, as the outcome of work at Jealott's Hill and elsewhere, that by the proper use of fertilisers not only can the yield of grass be increased quantitatively, but also valuable improvements effected in quality, i.e. food value, and in recovery from drought. By the improvement in quality the cost of expensive concentrated foods can be largely reduced. Practical suggestions as to how these advantages can be gained are contained in the chapters dealing with such topics, as the " Improvement of Pastures," the " Management of Grass Land," " Fertilisers on the Arable Farm," and " Soil Fertility." These are well worth the careful attention of all who may be able to play some part in helping to attain the objective set forth by the author, that the " home production of food, now a little less than two-fifths of the total quantity consumed, could be raised in the near future to more than one-half, and that this country could look forward to becoming, within a decade or so, all but self-supporting in milk, meat and the other animal products of the farm."

Soils : Their Origin, Constitution and Classification. By Gilbert Wooding Robinson, M.A. Pp. xv + 390, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Thomas Murby & Co., 1932.) Price 20s.

This book has been written primarily for the purpose of presenting within a reasonable compass a general view of the study of the soil as an object in itself rather than in relation to its economic or geographical importance. The development of the subject has been so rapid during recent years that the treatment is necessarily somewhat broad in outline in order to cover the whole field.

The book opens with a short introduction outlining the main principles of the study of the soil as a branch of pure science and its relation to agriculture and geology. This is followed by a series of chapters dealing with the constitution of the soil ; the various processes of soil formation and the relative importance of the factors, such as climate and drainage conditions, influencing the kind of soil formed ; the constitution and properties of the clay complex ; the processes of base-exchange and the part played by organic matter and by water.

The next six chapters are devoted to detailed descriptions of the main types of soil which are now recognised—the podsolic group ; the tshernosems ; those soils, including peats, which owe their distinctive characters to the presence of a ground-water table at or near the surface ; saline and alkaline soils ; soils of the humid regions of the tropics and subtropics, including laterites ; and soils associated with calcareous parent materials. A general description is given of each type, which is further illustrated by accounts of specific profiles from various parts of the world.

The author then reviews the various systems of soil classification which have been proposed from time to time, pointing out the importance of considering climate, geology of parent material and topography. The necessity for using the whole of the soil profile as the unit for any system of classification is particularly emphasised and the nature of the existing systems is shown to be provisional, largely on account of the limited amount of detailed quantitative work which has hitherto been done in relation to the total number of possible soil types in the world.

The next chapter contains an account, given with due reserve, of the geographical distribution of the main soil types and this is followed by a discussion of the aims and methods of soil surveys and soil analysis. The final chapter is concerned with the soil in its relation to plant growth and agriculture and draws attention to the vital importance of considering the conservation of the soil and the maintenance of soil fertility rather than immediate crop yields. There is a useful appendix outlining the chief methods used in the examination of soils and giving in detail the latest, and in the author's view, the most satisfactory, modifications of the international method of mechanical analysis. These modifications have been perfected in Professor Robinson's own laboratory, where the pipette method originated, and a detailed account of them is not at present readily available elsewhere.

The author has been remarkably successful in presenting, within the limits of a book of moderate size, a concise but comprehensive view of his subject and the book should prove of great value to all those who are interested from any point of view in the study of the soil.

METHODEN FÜR DIE UNTERSUCHUNG DES BODENS. By Dr. O. Lemmermann. Teil I. Pp. 90, $9\frac{1}{4} \times 6\frac{1}{4}$. (Berlin : Verlag Chemie, 1932.) Price MK. 6.

This small volume, which is published as a supplement to the *Zeitschrift für Pflanzenernährung, Düngung und*

Bodenkunde, has been compiled by Dr. Lemmermann with the collaboration of a committee representing jointly the Association of German Agricultural Experiment Stations and the German Society of Soil Science. It is intended to assist towards the provision of tested, and, where possible, uniform methods for the examination of soils.

The book is divided into sections, each devoted to the different aspects of soil examination. The first deals in considerable detail with the taking of samples of soil in the field for various purposes, such as chemical or microbiological examination, or the sampling of the whole soil profile. This section also includes a number of useful generalisations on the principles to be observed in sampling. The next section gives an account of certain of the physical methods now used in the examination of both mineral and humus soils; these include the mechanical analysis, specific gravity, water capacity, heat of wetting and hygroscopicity.

The third section treats of a large number of chemical determinations on mineral soils, of the methods for ascertaining manurial requirements, and of the microbiological examination, the last-named being regarded from the chemical point of view. The last two short sections deal with special examinations of moor and forest soils.

The book as a whole is well produced and should be an authoritative guide to the methods which can be recommended for the examination of soils. Some of the methods given are definitely regarded as standard, while of others it is stated that further work is desirable before they can be recommended. The treatment given is, however, somewhat uneven. This is particularly noticeable in the chemical section, where the details given for the actual methods of analysis are in many cases very meagre and difficult for an inexperienced worker to follow. Little attention seems to have been paid, also, to the necessity for "blank" determinations on the reagents used.

There are numerous references to further sources of information, but these take an unusual and somewhat misleading form, for instead of referring directly to the original paper, the reference is in most cases to a German textbook, such as Blanck's *Handbuch der Bodenlehre*, or to an abstract. This may be convenient, especially if the book is to be used by students, but it is apt to give an erroneous impression of the actual sources of the information. The book would also be improved by the provision of an index.

A NEW GEOLOGICAL MAP OF THE COMMONWEALTH OF AUSTRALIA. Scale 1 : 2,990,000 (1 in. = 47·2 miles approx.), with a volume of Explanatory Notes, by Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., M.A., F.R.S. (Pp. 177, 10 × 6¼.) Price unmounted, in four sheets, together with the Volume of Notes, 20*s*. net ; mounted on linen and dissected, in case, together with bound Volume of Notes, 42*s*. net. (London : Edward Arnold & Co., 1932.)

Following close on the heels of the Geological Map of India (noticed in this BULLETIN, 1932, **30**, 115) comes a new Geological Map of Australia in four sheets which, when mounted, together cover an area of about 7 ft. 6 in. by 6 ft., and include besides the Commonwealth, the Mandated territory of New Guinea. The last geological map of the whole of Australia was published in 1913 and was on a much smaller scale, so that the present map, which incorporates up-to-date information supplied by the various State Geological Surveys and others, undoubtedly supplies a need. The compilation was done by Sir Edgeworth David, assisted by Mr. H. E. C. Robinson and by Mr. Q. E. N. Hayes of the Geological Survey of Great Britain, while the drawing and lithography was carried out by the Government Lithographer at the Lands Department, Sydney. It is a useful map, and is rendered more instructive by the addition of several sections across important areas printed along the sides and bottom.

The Explanatory Notes by Sir E. David which accompany the map provide in a book of 177 pages an excellent account of the stratigraphical succession and tectonics of Australia, together with a summary of its physical and economic geology. The sections provided along the map margins are also explained in the booklet, which concludes with an historical review tracing the changes that have taken place in this part of the earth's crust throughout geological time.

These two publications together form an invaluable contribution to the study of Australian geology, and have been provided at a most reasonable price.

THE EXAMINATION OF FRAGMENTAL ROCKS. By Frederick G. Tickell. Pp. x + 127, 10 × 7. (California : Stanford University Press ; London : Humphrey Milford, Oxford University Press, 1932.) Price 29*s*.

The examination of fragmental rocks may be undertaken for a variety of different purposes, and so, for example, the soil expert, the economic mineralogist and the petroleum engineer have developed rather different

lines of approach according to the problems confronting them, since the various physical properties of the samples have not the same significance to each of these workers.

In this book the author has endeavoured to bring together in outline the methods adopted by workers in many different fields for their mutual benefit.

Apart from the introduction there are five sections dealing with size analysis, porosity and permeability, preparation of specimens, identification of minerals, and description of minerals found in sedimentary rocks. The first deals with methods used for ascertaining visually and mechanically the particle size distribution, the degree of rounding and the state of aggregation of the grains, and methods of sizing by screens and elutriators. The next section describes methods employed by different workers for measuring the porosity and permeability of coherent and incoherent rocks. The section on the preparation of specimens includes concentration by panning, heavy liquids, magnetic, electrostatic and dielectric methods. The methods for the identification of minerals are described without presupposing any knowledge of optical mineralogy, and, although ably presented and quite up to date, are too condensed to be readily assimilated by anyone previously unversed in the subject. The section covering the description of minerals deals with fifty-seven of the more common species encountered in detrital sediments and fragmental rocks. It includes some tables for the identification of minerals, but these have been photographically reduced to such an extent as to be almost unreadable without a lens. A useful bibliography is appended.

The book is a very able compilation, illustrated with good photographs and microphotographs, abounding in references and well printed, but in attempting to cover such a wide field in a hundred pages or so the author has produced something which in parts, at least, is little more than an inventory of methods.

TABLES OF CUBIC CRYSTAL STRUCTURE OF ELEMENTS AND COMPOUNDS. By I. E. Knaggs, Ph.D., and B. Karlik, Ph.D. With a section on Alloys by C. F. Elam, M.A., D.Sc. Pp. 90, 9¾ × 6. (London: Adam Hilger, Ltd., 1932.) Price 11*s.* 6*d.*

This little book summarises in a convenient form the principal data regarding the structure of cubic crystals for the use of X-ray investigators. The book falls naturally into two parts, namely " Elements and Compounds," by

Drs. Knaggs and Karlik, and " Alloys," by Dr. Elam. In addition to a fairly exhaustive bibliography, containing approximately 1,000 references, tables are given in which substances are arranged in alphabetical order with their chemical formulæ and cross-reference indices, while other tables are devoted to the classification of substances according to their lattice spacing in Ångström units.

The application of X-ray methods to the study of crystals has been particularly fruitful during the past few years, and the present summary should be of considerable assistance to those engaged in this fascinating field of research and investigation.

BAUXITE AND ALUMINOUS LATERITE. By Cyril S. Fox, D.Sc., M.I.M.E., F.G.S. Pp. xxxi + 312, 10 × 6¼. Second Edition partly rewritten and enlarged. (London: Crosby Lockwood & Son, 1932.) Price 30s.

As compared with its predecessor, the new edition differs in containing an additional 12 pages and 15 more illustrations. Embodied in the text are 41 pages of either new or rewritten matter, including an introduction of 11 pages, a recasting of pages 241 to 252, and the replacement of the statistical chapter (XI) by another, entitled " Supplementary Information," the author justifying the deletion of the statistics by stating that the data are available in the " Statistical Summary " of the Imperial Institute, which is published annually.

The new matter that has been introduced is mainly the result of the collection of a quantity of recent information on bauxite deposits and developments in the aluminium industry in Northern Ireland, France, Germany, Italy, Yugo-Slavia, Austria and Hungary by the author, who visited those countries in 1931, the bulk of the information being contained in Chapter XI.

The introduction, which contains a reprint of the preface to the original edition, gives some recent general information, but chiefly deals analytically and otherwise with terra rossa and other red clays in different countries, grey pyritic bauxite, fossils in bauxite and the origin of bauxite. Regarding the last, the author goes rather fully into the subject and gives his reasons for dividing bauxite, according to its origin, into two types: (1) the *lateritic* type of the Indian peninsula, the Gold Coast and British Guiana, and (2) the *terra rossa* (or true bauxite) type of France and the Mediterranean seaboard; which accounts for the change in title of the volume from *Bauxite* to *Bauxite and Aluminous Laterite*.

Of the remainder of the book the bibliography remains the same, but the index has been modified to suit the new edition.

PROTECTIVE FILMS ON METALS. By Ernest S. Hedges, M.Sc., Ph.D., D.Sc., A.I.C. Pp. xi + 276, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Chapman & Hall, Ltd., 1932.) Price 15s.

This book is one of a series of very useful monographs on applied chemistry, of which five have already appeared and a number of others are in course of preparation. The importance of the subject of corrosion of metals and its prevention is seen when it is realised, as the author points out, that about £500,000,000 is lost in the world every year through corrosion of metals.

In addition to the author's records of his own investigations, he has drawn upon those of about 200 research workers extending back for over 100 years, so that the book may certainly be looked upon as a standard work ; it will be found to be a mine of information.

The first six chapters, which constitute about two-thirds of the book, deal with the different types of corrosion, electro-chemical reactions, dissolution of metals in acids, alkalis, etc. ; oxides, and their protective effects ; the growth and breakdown of oxide films ; the tarnishing of various metals exposed to different gases of the atmosphere ; protection in liquid media ; the periodic passivity of iron and other metals ; types of anodic films and the results of experimental work in film formation on a number of metals.

The remainder of the book is devoted to the practical application of experimental data obtained as above, the six chapters containing sections on : protection and ornamentation of metals—in the case of iron including the familiar blueing, case-hardening, coslettising and parkerising processes, and in the case of aluminium, the anodic oxidation process ; stainless steels ; metal colouring ; oxidised finishes ; coating by hot dipping, including the zinc, tin, lead, terne plate and aluminium processes ; the treatment of metals for use in food-canning industry, which is treated rather fully ; electroplating with a number of different metals ; gilding and silvering ; metal film spraying ; cementation, including the sherardising, chromising and colorising processes ; other protective films produced by rolling and drawing, in the manufacture of Sheffield plate, and by chemical deposition.

The book concludes with a useful appendix on paints, enamels and lacquers, their compositions, protective qualities, and the effects of corrosion upon them.

The book can be confidently recommended to chemists, metallurgists and engineers as a valuable and up-to-date work.

FUEL TESTING: LABORATORY METHODS IN FUEL TECHNOLOGY. By Godfrey W. Himus, B.Sc., A.R.C.S., D.I.C., A.I.C., M.I.Chem.E. Pp. x + 257, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill Limited, 1932.) Price 15*s.*

This little book, by an expert on the subject of fuel technology, is a useful addition to practical manuals devoted to methods of testing different kinds of fuel. It deals in a concise and thorough manner with the sampling and analysis of coal and gas, and includes an outline of the standard methods of testing oil fuel. There are also chapters on technical pyrometry, and on the selection of coal for industrial purposes. References to literature on the subjects dealt with are given at the end of each chapter, and there is also a short bibliography.

The book should be of much assistance to those requiring reliable information on modern methods of testing fuel in the laboratory.

TECHNICAL DATA ON FUEL. Edited by H. M. Spiers, M.A., B.Sc., F.I.C. Third Edition. Pp. xv + 302, $7\frac{1}{2} \times 4\frac{3}{4}$. (London: The British National Committee, World Power Conference, 1932.) Price 12*s.* 6*d.*

The second edition of this useful book was reviewed in this BULLETIN (1930, **28**, 407), and little need be added to the observations then made. Much additional information has been included in the present edition, the book having expanded from 242 to 302 pages. The fact that three editions have been printed within less than four years indicates that the book meets a demand by supplying in a concise and readily available form information and tables necessary to those interested in the subject of fuel technology.

THE QUANTITY AND SOURCES OF OUR PETROLEUM SUPPLIES. By John Muirhead Macfarlane, D.Sc., LL.D., Litt.D. Pp. 250, $8\frac{3}{4} \times 5\frac{3}{4}$. (Philadelphia: Noel Printing Company, Inc., 1931.)

In this interesting book the author endeavours to prove that the petroliferous matter of oil shales of the United States has been derived principally from the remains of fishes. He considers that algæ, crustacea

and mollusca contributed only to a minor extent. He goes much further, and believes that all the crude petroleum directly discharged from gushing wells originated primarily and wholly in oil-shale rock. "Productive oil sands or sandstones that often underlie or overlie such oil shales," he affirms, "*are in no case oil producers*, they are purely retaining or *reservoir sands* which receive supplies of crude oil by escape and migration from oil shales." Hence oil shales are "considered by the author to be the only intrinsically rich oil rocks of the world."

In the bulk of the volume the author quotes extensively from recently published researches dealing with abundant fish remains from which originated the substance in oil shales which on distillation yields petroleum. Only certain North American formations are dealt with in detail, namely the Mowry shale of the Cretaceous, the freshwater Green River shales of the Eocene, and the Modelo-Monterey shales of the Miocene periods.

Although the author's views are of considerable interest, it may be pointed out that other writers place more emphasis upon the importance of vegetable and animal remains (other than those of fish) as the original source of petroleum.

The Potash Industry. A Study in State Control. By George Ward Stocking. Pp. x + 343, $7\frac{3}{4} \times 5\frac{1}{4}$. (New York: Richard R. Smith, Inc., 1931.) Price $3.00.

The author, who is Professor of Economics in the University of Texas, has dealt with his subject in masterly fashion. The work is erudite, and the author's comments on the various phases of the German potash industry should be read by all students of economics.

The first twelve chapters of this book describe the history of the industry.

About the year 1856 two shafts, put down by the Prussian State for the mining of salt, encountered, at a depth of 836 feet, salt contaminated with magnesium and potassium-chloride salts (*Abraumsalze*), which was dumped on the hillside as useless. Dr. Adolf Frank was the first to refine *Abraumsalz*, and in 1861 a factory for the production of potassium chloride was established in Stassfurt. In 1862, a shaft in the Duchy of Anhalt was put into operation, and during the next thirteen years, potash production was confined to the works of the above two States. On June 24, 1865, Prussia adopted the German Mining Law by which potash mining was thrown open to the public, and very soon capacity was greatly in excess of market requirements. In 1879, the first potash Cartel or Syndi-

cate was organised, a somewhat loose, semi-official State control being thereby set up. The Potash Law of 1910 placed the industry under the definite control of the Imperial Government. The author says that " under the tolerant influence of a paternalistic measure which aggravated the evils it was designed to curb, excess capacity in the potash industry continued its skyward flight." In four years after the passing of the law the number of shafts had increased from 73 to 194. In 1914, the output amounted to 8,042,453 long tons, and the value had declined by more than half. Then came the Great War, and in January 1915 potash was declared contraband. After the revolution of 1918, the socialists formed a Commission, by which final control, but not immediate administration, was to lie with the State. The Law for the Regulation of the Potash Industry was passed on April 24, 1919. The general supervision of the broader problems of the industry was put in the hands of an Imperial Potash Council—the *Reichskalirat*. By this law, the closing down of mines and the transfer of quotas were allowed.

The Alsatian potash deposits, after the war, passed into the hands of France, and, to prevent competition between the two countries, the Franco-German International Potash Control agreement was signed in Paris on December 29, 1926. Under the terms of the contract, the sales of potash within German territory are reserved exclusively to the German potash industry. Sales within French territory, including French colonies, protectorates and mandated territories, are reserved exclusively to the French industry. Total annual sales outside these reserved areas, as long as they remain under 840,000 metric tons of K_2O, are to be divided between Germany and France in the ratio of 7 : 3. Sales in excess of 840,000 metric tons are to be divided equally. The contract further provides for the establishment of a uniform price policy in foreign sales. " The stabilisation in foreign markets, at which the Franco-German accord aimed, has been achieved, and it is price stabilisation at levels higher than would have been likely in the face of competition."

The 13th chapter of the book deals with the prospects and problems of an American potash industry, the potash deposits in Texas and New Mexico, consisting of polyhalite and sylvite, are briefly described, and the question of comparative costs is discussed. The author states that if we assume that syndicate and selling expenses be brought to not more than 10 per cent. of the production costs (less than one-half that for the German industry), the average cost per ton of K_2O for American potash becomes $38.04,

as compared with an average figure for the German industry of \$37.15, exclusive of transportation charges.

Here, says the author, "is a virgin industry, as yet free from the tangled web of vested interests and conflicting private rights which have made so difficult a way of order for coal and iron. As such, it challenges the finest arts of statecraft and policy making."

HANDBUCH DER ANORGANISCHEN CHEMIE. Edited by Dr. R. Abegg, Dr. Fr. Auerbach and Dr. I. Koppel. Band IV, 3, II Lief. B 2, Komplexe Cyanide des zweiund dreiwertigen Eisens. Pp. xvii–xx + 465-674, 10 × 7. (Leipzig: Verlag von S. Hirzel, 1932.) Price RM. 24.

A further step towards the completion of Abegg's *Handbuch der anorganischen Chemie* is marked by the publication of another section of the final volume, dealing with the complex cyanides of iron.

The book opens with an historical introduction, tracing the development of the knowledge of the complex cyanides of iron from the discovery of Prussian Blue at the beginning of the eighteenth century, up to recent work on the possibility of isomerism of the ferro- and ferri-cyanides. Then follow four sections dealing respectively with the hexacyanides of bivalent iron, the hexacyanides of trivalent iron, the iron and copper salts of ferrocyanic acid (including Prussian Blue and related compounds) and the pentacyanides of bi- and trivalent iron. A valuable account of the methods for the detection and estimation of the ferro- and ferri-cyanides, together with their uses as analytical reagents, is given in the next section.

The colloidal phenomena exhibited by the iron cyanides have been fully investigated and many important contributions to colloid chemistry have resulted from their study. This aspect of the iron cyanides is described in the following section, special emphasis being laid upon the theoretical and practical significance of the formation of colloidal solutions of Prussian Blue and its related compounds and of the colloidal properties of copper ferrocyanide, together with the use of this compound in the preparation of semipermeable membranes.

The technology of the complex iron cyanides is described in the last section. This subject is obviously too wide for detailed treatment in a book of this type, but a concise account of the preparation and uses of the ferro- and ferri-cyanides is given, with references to other books of a more specialised character for further information.

A complete and well-arranged bibliography is appended, with references dating from 1710 to the present year.

There are still many gaps in our knowledge of this important group of compounds and this treatise should therefore prove of great service both to those who are seeking problems for investigation and to those who are already carrying out research in this field.

BOOKS RECEIVED FOR NOTICE

A MANUAL OF THE FLOWERING PLANTS AND FERNS OF THE TRANSVAAL WITH SWAZILAND, SOUTH AFRICA. Part II. Malvaceæ to Umbelliferæ. By Joseph Burtt Davy. Pp. xxxv + 273–529, $7\frac{1}{2} \times 5\frac{1}{4}$. (London: New York, Toronto: Longmans, Green & Co., Ltd., 1932.) Price 25*s.*

DIZIONARIO PRATICO DEGLI ALIMENTI. By Dott. Ettore Santangelo. Pp. l + 408, 10 × 7. (Milan: Ulrico Hoepli, 1932.) Price Lire 50.

ADULTERATION AND ANALYSIS OF FOODS AND DRUGS. By J. F. Liversedge, F.I.C., Ph.C. Pp. xv + 599, $10 \times 6\frac{1}{2}$. (London: J. and A. Churchill, 1932.) Price 36*s.*

THE MANUFACTURE OF BISCUITS, CAKES, AND WAFERS. By J. Fritsch, in collaboration with P. Grospierre. Adapted from the French by Charles M. Stern. Pp. xiii + 378, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1932.) Price 25*s.*

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Revised by W. Harrison Martindale, Ph.D., Ph.Ch., F.C.S. Twentieth Edition. Vol. I. Pp. xlviii + 1216, $6\frac{1}{2} \times 4$. (London: H. K. Lewis & Co., Ltd., 1932.) Price 27*s.* 6*d.*

NATURAL VARNISH RESINS. By T. Hedley Barry. Pp. xii + 294, $10 \times 6\frac{1}{2}$. (London: Ernest Benn Limited, 1932.) Price £2 2*s.* 0*d.*

IRRIGATION PRINCIPLES AND PRACTICES. By Orson W. Israelsen, Ph.D. Pp. xiv + 422, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 31*s.*

THE PRINCIPLES OF WOODWORKING. A SURVEY OF PRESENT KNOWLEDGE ON THIS SUBJECT. By W. W. Barkas, M.Sc., E. D. van Rest, B.A., B.Sc., and W. E. Wilson, M.A.S.W.-C.M. Department of Scientific and Industrial Research, Forest Products Research, *Bulletin No.* 13. Pp. vi + 35, 9½ × 7¼. (London: His Majesty's Stationery Office, 1932.) Price 2*s*. 6*d*.

A TEXTBOOK OF GEOLOGY. Part I: PHYSICAL GEOLOGY. By Chester R. Longwell, Adolph Knopf and Richard F. Flint. Pp. vii + 514, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 23*s*.

A TEXTBOOK OF MINERALOGY. By Edward Salisbury Dana. Fourth Edition, Revised and Enlarged by William E. Ford. Pp. xi + 851, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 34*s*.

TIN SOLDERS: A MODERN STUDY OF THE PROPERTIES OF TIN SOLDERS AND SOLDERED JOINTS. By S. J. Nightingale. Pp. viii + 89, 7½ × 5. (London: The British Non-Ferrous Metals Research Association, 1932.) Price 5*s*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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ABSORPTION OF WATER BY SISAL AND MANILA ROPES ON IMMERSION: INCREASE OF WEIGHT AND GIRTH

NUMEROUS experiments have been carried out at the Imperial Institute to determine the comparative behaviour of East African Sisal and Manila ropes when immersed in water with respect to (1) the rate of absorption of water, (2) the increase in girth of the rope, and (3) the reduction of girth of the rope when allowed to dry in the air. These observations were undertaken with the object of testing statements which have been made to the effect that Sisal ropes swell more rapidly than Manila ropes when wetted and therefore do not run satisfactorily through pulley-blocks, and that they do not recover their original girth when dried.

Experiments were started in 1925, but it was found that the method used at first for measuring the girth of the ropes was not sufficiently accurate to render the results entirely reliable.

Subsequent experiments have been carried out with an improved technique, and the results obtained are in general agreement.

Procedure.—In the following experiments the ropes examined were all treated in exactly the same way.

Test pieces of a total length of 39 in. were used, and, to prevent unlaying, the rope was bound at each end with copper wire, the weight of such binding being the same for each specimen in a series of tests. The distance between the two bindings was adjusted to exactly 36 in.

The increase in weight of the ropes was determined in the following manner. At the end of the immersion period the rope was removed, the excess of water shaken off and the rope allowed to drain for 5 minutes. The increase in weight was then noted, and the percentage increase was calculated on the weight of the original rope without the weight of the binding.

The girth determinations were made with special rope callipers, ten measurements being taken along the length of the rope and averaged. In Series II (7-in. ropes) callipers with specially widened jaws were used.

I. Experiments with 3-in. Ropes

The following results were obtained for pieces of 3-in. East African Sisal and Manila ropes, all made to the same specification, after immersion in fresh water for different periods:

Percentage Increase in Weight of 3-in. Ropes

Period of Immersion.	No. 1 East African Sisal Brushed.	No. 1 East African Sisal Unbrushed.	Manila S3.	Manila K.	Manila M1.
After 2 hours' immersion .	42·9	56·0	18·5	24·1	16·7
After a further 4 hours (total 6 hours) .	46·4	60·0	44·4	37·9	26·7
After a further 17 hours (total 23 hours) .	50·0	60·0	48·1	44·8	36·7
After a further 144 hours (total 167 hours) .	53·6	64·0	63·0	65·5	60·0
After 7 days' air-drying .	3·6	8·0	11·1	10·3	6·7

Increase in Girth of the Ropes

Period of Immersion.	No. 1 East African Sisal Brushed.	No. 1 East African Sisal Unbrushed.	Manila S3.	Manila K.	Manila M1.
	in.	in.	in.	in.	in.
Original girth .	3	2¾	3	3	3
After 2 hours .	3¼	3¼	3⅛	3¼	3¼
After a further 4 hours (total 6 hours) .	3¼	3¼	3¼	3¼	3¼
After a further 17 hours (total 23 hours) .	3¼	3¼	3¼	3¼	3¼
After a further 144 hours (total 167 hours) .	3¼	3¼	3⅜	3½	3½
After 7 days' air-drying .	3	2⅞	3⅛	3¼	3¼
Increase on original girth .	nil.	⅛	⅛	¼	¼

Rate of Absorption.—These results show that Sisal rope absorbs water very rapidly during the first 2 hours. In the case of the Manila ropes the initial gain in weight up to 2 hours was approximately only half of that of the Sisal; after this period the absorption continued at a steady rate and ultimately to a greater extent than in the sample of No. 1 Sisal Brushed.

Increase in Girth.—With the exception of the No. 1 Unbrushed Sisal all the ropes showed the same increase in girth after a period of 4 hours. The girth subsequently remained constant in the case of the Sisal ropes. The Manila ropes, however, continued to increase in girth until the conclusion of the experiment. On air-drying, the No. 1 Brushed Sisal was the only rope to recover its original girth, and the order of recovery was as follows:

	Original Girth. *in.*	After Air-drying. *in.*
No. 1 Sisal Brushed	3	3
No. 1 Sisal Unbrushed	$2\frac{3}{4}$	$2\frac{7}{8}$
S3 Manila	3	$3\frac{1}{8}$
K Manila M1 Manila	3	$3\frac{1}{4}$

These experiments indicate that Sisal rope absorbs water at approximately twice the rate of Manila in the initial stages of immersion and that the absorption of water by the Sisal rope takes place chiefly during the first two hours. As regards swelling, the Sisal rope remained unaltered in girth after this period, whereas the Manila increased. On air-drying the No. 1 Brushed Sisal was the only rope to recover its original girth.

II. Experiments with 7-in. Ropes

Further experiments using 7-in. ropes, all made in the same way and by the same manufacturer, were carried out under similar conditions, and the results obtained are shown on page 410.

Rate of Absorption.—The results obtained in these experiments are more or less in agreement with those obtained in the previous experiments.

The Sisal rope was again found to have absorbed most of its water in the initial stages.

PERCENTAGE INCREASE IN WEIGHT OF 7-IN. ROPES

Period of Immersion.	No. 1 East African Sisal.	High-grade Manila.	Standard Quality Manila.
After 2 hours	45	38	40
After a further 4 hours (total 6 hours)	52	46	48
After a further 17 hours (total 23 hours)	54	52	56
After a further 144 hours (total 167 hours) . . .	59	64	67
After 192 hours' air-drying .	17	15	14
After a further 336 hours (total 528 hours) . . .	2	2	3

INCREASE IN GIRTH OF 7-IN. ROPES

Period of Immersion.	No. 1 East African Sisal.		High-grade Manila.		Standard Quality Manila.	
	in.	*increase.*	*in.*	*increase.*	*in.*	*increase.*
Original girth	6⅝	—	7	—	6¾	—
After 2 hours' immersion .	7	⅜	7¼	¼	7⅜	⅝
After a further 4 hours (total 6 hours)	7⅛	½	7⅜	⅜	7⅜	⅝
After a further 17 hours (total 23 hours) . .	7⅛	½	7⅜	⅜	7½	¾
After a further 144 hours (total 167 hours) . .	7⅛	½	7½	½	7½	¾
After 192 hours' air-drying .	7	⅜	7⅛	⅛	7½	¾
After a further 336 hours (total 528 hours) . .	6¾	⅛	7 $\frac{1}{16}$	$\frac{1}{16}$	7¼	½

The Manila ropes, while showing a rather larger initial percentage absorption in these experiments than was the case in the first series, still showed a steady increase in weight towards the later periods of immersion and ultimately absorbed rather more water than the Sisal rope.

Increase in Girth.—The behaviour of the ropes in this respect was generally similar to that of the ropes in the first series.

The Sisal rope after a total of six hours' immersion had increased ½ in. in girth, and the girth then remained constant throughout the experiment. The Manila ropes, however, continued to increase in girth and at the conclusion of the experiment the following actual increases were noted :

	in.
No. 1 East African Sisal	½
High-grade Manila	½
Standard Quality Manila . . .	¾

None of the ropes recovered their original girth on air-drying, but they showed the following increases over the original girth : No. 1 East African Sisal, $\frac{1}{8}$ in. ; High-grade Manila, $\frac{1}{16}$ in. ; Standard Quality Manila, $\frac{1}{2}$ in.

III. Further Experiments with 3-in. Ropes

A further series of experiments with 3-in. ropes (all made to the same specification) has been carried out and the results obtained generally confirm those of the previous tests. The time of the first immersion period was shortened to 1 hour. The results obtained were as follows :

Percentage Increase in Weight of 3-in. Ropes

—	Periods of Immersion.				Air-drying.	
	1 hour.	After further 2 hours (total 3 hours).	After further 3 hours (total 6 hours).	After further 17 hours (total 23 hours).	After 144 hours.	After further 240 hours (total 384 hours).
Lugalla Sisal . .	53·6	58·9	60·7	64·3	7·1	1·8
Amboni Sisal . .	55·0	60·0	60·0	63·3	6·7	1·7
Artificially-dried Sisal . .	45·6	49·2	49·2	54·4	7·0	3·5
Thika Sisal . .	51·0	54·6	56·5	60·1	5·4	3·7
K Manila . .	23·3	33·3	40·0	46·7	6·7	0·0
S3 Manila . .	34·6	41·9	47·3	52·8	7·3	1·9

Increase in Girth of 3-in. Ropes

—	Original Girth.	Periods of Immersion.				Air-drying.		
		1 hour.	After further 2 hours (total 3 hours).	After further 3 hours (total 6 hours).	After further 17 hours (total 23 hours).	144 hours.	After further 240 hours (total 384 hours).	Increase on Original Girth.
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
Lugalla Sisal .	$3\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{5}{8}$	$3\frac{1}{2}$	nil.
Amboni Sisal .	$3\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{7}{8}$	4	4	$3\frac{3}{4}$	$3\frac{5}{8}$	$\frac{1}{8}$
Artificially-dried Sisal .	$3\frac{3}{8}$	$3\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{7}{8}$	$3\frac{7}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$\frac{1}{4}$
Thika Sisal .	$3\frac{1}{4}$	$3\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{7}{8}$	$3\frac{7}{8}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$\frac{1}{4}$
K Manila .	$3\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$\frac{1}{8}$
S3 Manila .	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$\frac{1}{4}$

Remarks

In considering the figures given in this report, it should be borne in mind that although great care was taken in the

experiments to render the measurements as exact as possible, certain obstacles were encountered which made a high degree of accuracy unattainable. Among these are the two following factors :

(1) The unequal circumference of the rope, and the difficulty of taking girth measurements in exactly the same places along the length of the rope.

(2) The ropes, more particularly the Sisal, when wetted for a considerable period are liable to unlay and spread slightly. On drying, this is still more noticeable and may account to some extent for the statement that Sisal rope does not recover its original girth on drying.

From the foregoing experiments it may be definitely stated that Sisal rope absorbs water very rapidly. The bulk of the absorption would appear to occur in the first hour, after which the increase in weight of the ropes is comparatively small.

Manila rope on the other hand has a much slower rate of absorption, but after a prolonged period of immersion (167 hours or more) appears to take up as much water as Sisal rope or rather more.

With regard to the swelling of the ropes, the difference between the Sisal ropes and the Manila ropes is not very marked, although in the earlier stages the advantage lies on the whole with the Manila. After a period of immersion of two hours, however, the increase of girth of the Manila rope becomes approximately the same as that of the Sisal rope.

The rate of shrinkage on drying is approximately the same in both Sisal and Manila ropes. The Sisal rope on drying tends to recover its original girth to about the same extent as the Manila rope, there apparently being, on the average, very little difference in this respect. It will be seen that in the majority of cases the shrinkage is greatest in the Sisal rope, and that, on the average of the whole of the experiments, the Sisal rope has more nearly returned to its original girth than the Manila rope.

EDIBLE BEANS FOR THE ENGLISH MARKET

THE beans which are imported into the United Kingdom fall into two categories : those suitable for human consumption and those used as food for livestock. The beans most in demand for the former purpose are certain kinds of white beans, such as the large Madagascar or butter bean (a variety of *Phaseolus lunatus*) and a smaller type, known collectively as haricots. Attempts have been made from time to time to introduce other kinds but, if differing in shape or size from those in popular demand or having a coloured seed-coat, it has been found impossible to sell them, except at a relatively low price for cattle-feeding.

Of the haricot beans proper (forms of *Phaseolus vulgaris*), two principal kinds are recognised here, viz. Danubian and Japanese. Two varieties of the latter come on the market, " Ohtenashi " from Japan and " Kotenashi " from Korea. Another type which enters this country in considerable quantity and which is sometimes classed as a haricot is the white Rangoon bean (a variety of *Phaseolus lunatus*). This approximates to the true haricot in size, but always realises a lower price, on account of its inferior colour.

The Lima bean (another variety of *Phaseolus lunatus*), which occasionally comes here, is a white bean intermediate in size between the Madagascar bean and the Rangoon bean.

The Chilean white bean, which is a large variety of the true haricot, finds its principal market in the North.

The beans used for feeding livestock include principally the field or horse bean (*Vicia Faba*) and various small-seeded and coloured beans derived from a number of species of *Phaseolus*. It is not proposed to deal with this class of beans in the present article, but those interested will find an account of the different kinds in an article on " The Peas and Beans of Commerce," published in this BULLETIN (1917, **15**, 503–544).

With the exception of the Rangoon bean, which comes from Burma, practically the whole of our supplies of white beans is derived from foreign sources, as is shown in the following tables which give the imports of haricot beans

and butter beans into the United Kingdom during recent years. The Rangoon bean is included in the Board of Trade Returns under the heading "Haricot."

IMPORTS OF HARICOT BEANS INTO THE UNITED KINGDOM

Countries whence consigned.	Quantity.			Value.		
	1929.	1930.	1931.	1929.	1930.	1931.
	cwts.	cwts.	cwts.	£	£	£
Germany	5,521	11,233	6,532	8,869	15,798	7,290
Netherlands	3,583	2,128	2,030	7,027	2,216	1,298
Belgium	9,900	7,631	29,854	14,133	7,267	12,943
France	1,547	2,072	4,750	2,916	2,683	3,786
Roumania	—	8,440	8,248	—	9,937	6,149
Japan	7,279	12,178	102,346	9,757	13,948	52,439
Chile	6,889	4,109	11,816	12,228	4,734	9,644
Other Foreign Countries	5,838	4,313	15,346	9,320	5,485	8,238
Total from Foreign Countries	40,557	52,104	180,922	64,250	62,068	101,787
British India	140,512	49,917	89,128	128,126	25,908	34,033
Other British Countries	1,907	14	284	2,148	79	166
Total from British Countries	142,419	49,931	89,412	130,274	25,987	34,199
Total	182,976	102,035	270,334	194,524	88,055	135,986

IMPORTS OF BUTTER BEANS INTO THE UNITED KINGDOM

Countries whence consigned.	Quantity.			Value.		
	1929.	1930.	1931.	1929.	1930.	1931.
	cwts.	cwts.	cwts.	£	£	£
Madagascar	144,397	280,705	171,578	256,727	424,924	188,112
Other Foreign Countries	8,151	2,096	30	13,861	3,054	15
Total from Foreign Countries	152,548	282,801	171,608	270,588	427,978	188,127
Total from British Countries	731	2,883	—	1,402	2,286	—
Total	153,279	285,684	171,608	271,990	430,264	188,127

In recent years attention has been given in many parts of the Empire, particularly in India and Africa, to the question of growing edible beans for export to this country. Samples produced in the course of experiments in several of these countries have been received for examination at the Imperial Institute and the reports on their investigation which are printed in the following pages

are of interest as indicating the possibilities in the countries concerned.

For the guidance of those contemplating carrying out experiments with this class of beans, the following notes on the market requirements and conditions in the United Kingdom have been compiled, largely from information kindly furnished to the Imperial Institute by firms engaged in the bean trade in London.

The kind of bean to be grown will be determined by the local conditions of soil and climate. It will be necessary therefore in the first place to carry out experiments with a range of those varieties which are most in demand. If it is found that the Madagascar bean grows well and gives a good yield of beans of suitable quality, that kind should certainly be given preference over the others, as it realises a very much higher price. It may be remarked, however, that this variety has frequently shown a tendency to deteriorate in size when grown in a new country, and it may be found more desirable to grow one of the haricots. Of these the order of preference would be first Danubian, second Ohtenashi and third Kotenashi. The Rangoon bean would only be worth trying if all the other kinds failed to give remunerative returns. In addition, there may be indigenous varieties which might be profitable to grow, but these would have to approximate very closely to kinds already in popular demand if they are to find an assured and constant market. As an example of this type of bean, reference may be made to the beans from Nyasaland and Basutoland dealt with on pages 423 and 432 of this article.

The prices of white beans have fallen considerably during the last year or two, as is shown in the following table giving the spot prices of beans in London at the beginning of the months quoted.

—	Madagascar.	Danubian.	Ohtenashi.	Rangoon.
	Per cwt.	*Per cwt.*	*Per cwt.*	*Per cwt.*
Jan., 1930 .	46*s.*–48*s.*	27*s.*–27*s.* 6*d.*	22*s.* 6*d.*	14*s.*
June, 1930 .	35*s.*–36*s.*	18*s.* 6*d.*–19*s.*	19*s.* 6*d.*	11*s.* 3*d.*
Jan., 1931 .	26*s.*–27*s.* 6*d.*	15*s.* 9*d.*	14*s.*	9*s.*
June, 1931 .	21*s.*–22*s.*	—	9*s.* 6*d.*	8*s.* 6*d.*
Jan., 1932 .	21*s.* 6*d.*–23*s.* 6*d.*	11*s.*	11*s.* 6*d.*	9*s.*
June, 1932 .	22*s.*–23*s.* 6*d.*	—	8*s.* 3*d.*–8*s.* 9*d.*	7*s.* 3*d.*–8*s.* 9*d.*
Dec., 1932 .	22*s.* 6*d.*–23*s.*	10*s.*	10*s.*	8*s.* 6*d.*

Kotenashi beans are not regularly quoted, but they usually realise somewhat less than the Ohtenashi.

The factor of first importance in determining the value of white beans is the colour of the seed-coat ; the internal colour is not taken into consideration provided it is not abnormal. Other points upon which the value depends are uniformity of size, freedom from insect attack, absence of " yellow eye " (a yellow band surrounding the hilum), weathering marks and cleanness. It is important that the beans be hand-picked and graded to size.

Madagascar beans and Japanese haricots are packed in bags of 100 lb. gross, but the Danubian haricots are generally shipped in bags of 2 cwts. The last-named, however, can be packed in bags of 100 lb., if more convenient to the shipper ; in fact, the Imperial Institute understands that the trade in London prefer the beans packed in the smaller bags.

With regard to buying contracts, as the quality of beans from a new producing country would not be known on the London market, buyers here would only buy on a sample in the first instance, and such sample would, of course, have to represent the bulk.

Madagascar Beans from Burma

A sample of Madagascar beans, grown at Amarapura, was forwarded by the Economic Botanist, Mandalay, in July, 1931.

The beans were of good colour and uniform strain. They were of good size, free from yellow eye and weathering marks, and of normal plumpness.

The beans were analysed with the following results, which are shown in comparison with the corresponding figures for a sample of Madagascar beans from Natywagon, Burma, previously examined at the Imperial Institute (this Bulletin, 1915, **13**, 199).

	Present sample from Amarapura. *Per cent.*	Previous sample from Natywagon. *Per cent.*
Moisture	12·7	12·5
Crude proteins	17·3	25·7
Fat	1·1	0·9
Carbohydrates, etc. (by difference)	59·9	53·9
Crude fibre	4·5	3·4
Ash	4·5	3·6
Nutrient ratio	1 : 3·6	1 : 2·2
Food units	106	120

The present beans yielded on autolysis 0·0075 per cent. of prussic acid.

A cooking trial was carried out with the beans in comparison with a commercial sample of Madagascar butter beans obtained in London. Good results were obtained, showing that the Amarapura beans were quite satisfactory in this respect.

The beans were submitted to a firm of importers in London, who described them as of excellent colour and equal in general appearance to the best quality of Madagascar beans imported into the United Kingdom in normal seasons. The firm considered that such beans should realise the full market price of the Madagascar product, then quoted at £18 per ton c.i.f. London (October, 1931), and expressed their willingness to receive at any time shipments of beans of similar quality.

The results of chemical examination showed that these beans from Amarapura were of normal composition, although they did not contain as much protein as the sample from Natywagon examined in 1915, in which the amount of this constituent was rather high. The figures for crude proteins in Madagascar beans usually range from 18·0 to 20·6 per cent. The amount of prussic acid yielded by the beans on autolysis was normal, and satisfactorily low, indicating that the beans would be quite suitable for human consumption.

The beans were of excellent quality and consignments of similar character would be readily marketable in the United Kingdom at the current price ruling for Madagascar butter beans.

Beans from Burma

Four samples representing Burma "butter beans" and Pebyugale (Rangoon white beans) from the 1930–31 crop were received from the Deputy Director of Agriculture, Myingyan Circle, Meiktila, and the Deputy Director of Agriculture, East Central Circle, Pyinmana, early this year. It was stated that the beans from the East Central Circle were grown in the Yamethin district.

The samples were as follows :

"Butter Beans"

From Myingyan Circle.—These beans were much smaller than the butter beans of commerce and differed from the latter in shape. They were plump, had a rather yellowish tinge, and many had yellow patches. The sample showed signs of insect attack.

From East Central Circle (Yamethin).—These beans were similar in size and appearance to the above sample, but were of good creamy-white colour, free from yellow patches and not quite so plump.

Pebyugale (Rangoon White Beans)

From Myingyan Circle.—Small, plump beans of variable size and fairly good colour, but a few had yellow patches. The sample showed signs of insect attack.

From East Central Circle (Yamethin).—Small, plump beans, of good colour and even size. A few showed yellow patches, but the beans were of better colour and more uniform in size than those from Myingyan.

The samples were submitted to two firms of importers in London, whose observations on both types of bean are summarised below under the headings (*a*) and (*b*) respectively. The prices quoted relate to the position in March, 1932.

"Butter Beans"

(*a*) These beans are not so large as the butter beans of commerce and would not be classified or sold as such. They occupy a position as regards size between butter beans and Rangoon beans. They are not a regular article of commerce on the United Kingdom market. The firm thought that with propaganda and effort a demand could be created for this class of bean, which would at first have to be sold on sample and when sufficiently well known could then be bought on description. They preferred the sample grown in the Yamethin district, but considered that both samples would at present possibly be worth about 12*s.* per cwt. in London. At this figure the trade would be rather speculative, but they thought there was a reasonable chance of obtaining about the price mentioned.

(*b*) The second firm also said that neither sample represented butter beans, and described them as the " large Lima " variety. Although there is no regular demand for such beans in the United Kingdom the firm stated that they could probably dispose of a shipment at the present time at from 8*s*. 9*d*. to 9*s*. 3*d*. per cwt. c.i.f., with Madagascar butter beans at 24*s*. per cwt. It might be possible to create a market for such beans, but it would be preferable to grow true Madagascar butter beans in Burma.

Rangoon White Beans (*Pebyugale*)

(*a*) These beans are true to type and the Myingyan sample is equal to the consignments of Rangoon White beans now being offered on the market. The Rangoon beans now imported from Burma, however, will not pass the requirements of the Board of Trade for use on board ship, on account of variable size and the presence of yellow beans, and the demand is therefore limited. White Rangoon beans were recently offered on the market at £9 per ton for the new crop, but there were no buyers at this price. The old crop was then being quoted at £7 5*s*. per ton. The firm considered the gap between these two prices too wide, as the difference should not be more than 10*s*. per ton.

The firm considered the Yamethin beans to be superior to those from Myingyan and stated that they would be readily saleable at £8 per ton c.i.f. London. They would satisfy the Board of Trade requirements, and if sufficiently large quantities could be offered this would tend to re-establish the demand for White Rangoon beans.

(*b*) The second firm also considered the sample from Yamethin to be of distinctly better colour than that from Myingyan, but stated that such beans do not find such a ready sale in London as formerly as the market is almost restricted to the supplying of ships' stores. They valued the Yamethin sample at 7*s*. 9*d*. and the Myingyan beans at 7*s*. 3*d*. per cwt. with Rangoon white beans at 8*s*. 6*d*. c.i.f.

Two further samples of the same types of beans were forwarded by the Deputy Director of Agriculture, Northern Circle, in May, 1932.

They were as follows :

Moki Lima Beans (" butter beans ").—Medium-sized beans, of good creamy-white colour and fairly plump. The beans were free from " yellow eye " and yellow patches.

These beans, like those from the Myingyan and East Central Circles, were much smaller than the butter beans of commerce and would not be classed or sold as such. They are not regularly marketed in the United Kingdom, but a firm of importers consulted by the Imperial Institute considered that it might be possible to dispose of shipments under the designation " Large Lima " beans at about 12*s*. per cwt. Another firm stated that there is no regular market for such beans in the United Kingdom but they considered that beans of the quality of this sample would be worth about 9*s*. per cwt. in London, with Madagascar butter beans at 24*s*. per cwt. (July, 1932).

Rangoon Beans.—Small plump beans of good creamy-white colour and fairly even size. A few had slight yellow patches.

This sample represented a normal type of Rangoon white beans as now offered on the London market, and consignments of uniformly good colour and even size should be saleable in London at 8*s*. per cwt. (July, 1932).

Beans from Kenya

Four samples, stated to represent varieties of white beans of the small haricot type, were forwarded by the Acting Director of Agriculture, Kenya, in August, 1931. It was desired to ascertain their quality and value, especially for use in the canning industry, in comparison with beans of similar type already imported into the United Kingdom.

The samples were as follows :

(1) *Boston Lima*.—White beans, with occasional faint brown specks and in general not of such good white colour as commercial Ohtenashi beans. They were of rounded oval shape, similar to that of Ohtenashi beans, but plumper and slightly shorter. The skins were glossy, and did not appear to be thicker than those of Ohtenashi beans.

(2) *Ohtenashi*.—These beans were generally similar in appearance to commercial Ohtenashi, but not of quite such

a good white colour. A few were rather brownish. The beans were plump and in good condition.

(3) *Kotenashi.*—Beans of poor appearance, and of brownish-white tint, darker than is usual for the Kotenashi variety. The beans were similar in shape to commercial Kotenashi, but many were shrunken and badly discoloured. The sample contained live weevils, and some beans were damaged.

(4) *Noyeau Blanc.*—Slender, kidney-shaped beans, white in colour with a slight yellow tint round the hilum. The beans were plump and in good condition.

Cooking trials carried out at the Imperial Institute with samples (1) and (2) in comparison with commercial Ohtenashi beans showed that they compared very favourably with the latter product. The flavour of the cooked Boston Lima beans (No. 1) was similar to that of the commercial Ohtenashi beans, whilst that of the Kenya Ohtenashi (No. 2) was slightly milder.

The beans were submitted to a firm of importers in London, who furnished the following observations on their quality and value (November, 1931).

" *Boston Lima.*—These are more uniform in size than commercial Ohtenashi beans, but not so pale in colour.

" *Ohtenashi.*—These are also less pale than commercial Ohtenashi beans.

" Both the above samples would be suitable for table use and also for canning. Their current value would be 8*s.* 9*d.* to 9*s.* 3*d.* per cwt. c.i.f. London with Ohtenashi beans at 9*s.* 6*d.* per cwt.

" *Kotenashi.*—These beans are of inferior colour and badly marked, and many of them are shrunken. In the condition of the sample they would only be suitable for grinding for use in feeding materials, for which purpose their value in London at the present time would be 7*s.* per cwt. c.i.f. If, however, this variety could be produced so as to conform to the normal appearance and quality of commercial Kotenashi beans, consignments would be readily saleable, the price for Kotenashi being about 6*d.* per cwt. less than Ohtenashi.

" *Noyeau Blanc.*—These beans would be unsaleable for human consumption in the United Kingdom, as they are

of a type which is not in public favour in this country. They could, however, be marketed on the Continent of Europe where their current value is 14*s*. to 15*s*. per cwt."

It will be observed from the foregoing report that beans of the types represented by samples Nos. 1 and 2 (Boston Lima and Ohtenashi) would be saleable in this country, either for table use or canning, at prices approximating to those current for Ohtenashi beans. The Kotenashi beans (No. 3), if they can be produced of better colour and quality, would also be saleable at a slightly lower price for the same purposes.

Ohtenashi beans are preferred in the United Kingdom to the Kotenashi and Boston Lima types and command a rather higher price on account of their whiter appearance. If similar yields are obtainable in each case it may be advisable to encourage the cultivation of the Ohtenashi rather than of the two other types.

The Noyeau Blanc beans do not conform to the type demanded by public taste in this country for table use, but they are stated to be saleable on the Continent where they are in favour for human consumption and realise higher prices than the other three varieties dealt with above.

Kadwengwa Beans from Tanganyika

The sample of beans which is the subject of this report was forwarded by the Director of Agriculture in August 1931. It was stated to represent a white runner bean which is grown in considerable quantities by natives in the Kasulu area of the Kigoma Province and was thought to be of a type which might possibly be profitably exported.

The sample consisted of beans which were similar to commercial Ohtenashi beans in shape, but not quite so large. They were, moreover, mostly of an inferior cream tint, whilst some were slate grey and had a black ring round the hilum. A few beans had been attacked by insects. Some were slightly earthy, and some showed reddish-brown patches which, judging from the stains on the bag in which they were contained, were apparently due to external contamination.

The beans on autolysis yielded no prussic acid, showing that they were free from cyanogenetic glucosides. On carrying out a cooking trial in comparison with commercial Ohtenashi beans it was found that the present sample took longer to cook, and that the slaty-grey beans turned brown; the flavour of the cooked beans was, however, satisfactory.

The beans were submitted to a firm of importers in London who furnished the following observations:

"The colour is poor, due possibly to the age of the sample. The new crop might be of better colour. The beans are a little earthy. The slaty-grey beans (known as 'rogues' in the trade) would detract from the value, and should be picked out; on cooking they would turn dark coloured. Beans as per sample would not be saleable for human consumption on account of the presence of some which had been attacked by insects; they would have to be sold as a food for animals and would be worth not more than £5 per ton. Even if the sample were free from insect attack and slaty-grey beans, the price would still be below that of Ohtenashi beans on account of the poor colour."

The current price of Ohtenashi beans in London (November, 1931) is 8*s*. 9*d*. per cwt. c.i.f. for October–November shipment and 9*s*. 9*d*. per cwt. for the new crop.

Beans from Nyasaland

The sample of beans which is the subject of this report was forwarded to the Imperial Institute by the Secretary of the Empire Cotton Growing Corporation, in May, 1932.

The beans were stated to represent the 1932 crop of a type of native bean known as "Mbwanda." They had been grown from seed selected at random from a bag of the beans in 1929 by an officer of the Corporation for trial sowing and had proved very suitable for cultivation.

The sample was labelled "Makwapala 1932 crop. White Haricot Selection." It consisted of long, plump, kidney-shaped beans of ivory-white colour, averaging 0·46 gram in weight. A few of the beans showed yellowish patches, and some had slight "yellow eye."

The beans were analysed with the following results :

	Per cent
Moisture	12·2
Crude proteins	19·4
Fat	1·6
Carbohydrates, etc. (by difference)	58·8
Crude fibre	4·3
Ash	3·7
Nutrient ratio	1 : 3·2
Food units	111

These results show that the beans contained a satisfactory percentage of proteins, very similar to that found in commercial Rangoon and Madagascar beans.

The beans were submitted to a firm of importers in London who described them as a very good sample of "white kidney" beans, supplies of which from the Continent were then being offered in the United Kingdom at £14 per ton (June, 1932). The Nyasaland beans would probably be worth about this price, with Rangoon white beans at £7 5*s*., Japanese Ohtenashi at £9 and Madagascar butter beans at £22. The firm mentioned, however, that the demand for white kidney beans in the United Kingdom is comparatively small.

A second firm expressed the view that the beans would not find a remunerative outlet in the United Kingdom, but they suggested that it might be worth while to test the market by forwarding a trial shipment of a few tons for sale in London. The firm stated that the beans would be readily saleable on the Continent of Europe, especially in centres such as Marseilles, Antwerp and Rotterdam.

Beans from Nigeria

Seven samples of beans produced experimentally in Nigeria were forwarded by the Senior Botanist, Agricultural Department, Zaria, in March, 1931.

The following list includes descriptions of the samples and observations regarding their characters from the commercial standpoint.

No. 1. *Madagascar beans from seed supplied by the Imperial Institute.*

Colour.—Cream. Some beans show slight "yellow eye," and/or slight weathering discolorations.

Shape.—Some have the normal shape of Madagascar beans, while some show the form of the Lima bean.

Size.—Very variable. From $\frac{7}{16}$ to 1 inch in length. Fairly plump.

The colour of these beans is good. The discolorations are very slight, and probably not sufficient to affect the market value. The serious defect of this sample is its mixed character in size and shape, two distinct varieties being represented, viz. the Madagascar bean of large size and the smaller Lima bean. Such a mixture would not be easily saleable and the separation of the two types by grading would be desirable.

No. 2. Madagascar beans from seed supplied by the Imperial Institute.

Colour.—Cream. Practically free from discoloration.

Shape.—Mostly of normal Madagascar type, but some of the smaller beans resemble Lima beans in shape.

Size.—Very variable, from $\frac{1}{2}$ to 1 inch in length, but as stated above the bulk of the sample consists of large Madagascar beans. Fairly plump.

The sample is much better as regards size and uniformity than No. 1, but its value would be increased by separating the smaller beans. The colour is good and the sample is better on the whole in colour and freedom from discoloration than No. 1, and also superior in this respect to the original Madagascar seed supplied by the Imperial Institute. The beans, however, are not so plump as the seed sample. The size, ignoring the beans of Lima form, is not so good on the whole as the seed sample, but nevertheless quite satisfactory.

No. 3. *Small Lima from England,* 1928.

Colour.—Brownish-cream, with strong brownish-yellow weathering marks in many cases.

Shape.—Similar to that of Rangoon White beans. Plump on the whole, but some rather weak.

Size.—From $\frac{5}{16}$ to $\frac{1}{2}$ inch in length.

Though most of these beans are plump, some are not well filled out and suggest immaturity or poor growth. The discoloration is excessive, and would seriously affect the value, as colour is a very important factor in this respect.

No. 4. *From Nyasaland.*

Colour.—Cream. With slightly yellow-tinted eyes.

Shape.—Normal flat Lima. On the whole plump.

Size.—$\frac{3}{8}$ to $\frac{5}{8}$ inch.

These beans are of good colour and the slight discolorations are not pronounced enough to affect the market price. The product is comparable in quality and value with commercial Ohtenashi beans.

No. 5. *A Burpee Bush Lima,* 1929.

These beans are generally similar to No. 4, but somewhat inferior to the latter in colour, being of a darker cream tint with more pronounced discolorations. Their value would probably be lower than that of No. 4.

No. 6. *From Nyasaland,* 1930.

Generally similar to No. 5, but of rather better colour.

No. 7. *A Native Bean,* 1930.

Similar to No. 3, but slightly larger and more plump. The discolorations are similar to those of No. 3, but not quite so excessive.

The beans were submitted to two firms of merchants in London for observations regarding their quality and value.

(1) One firm furnished the following report :

Sample No.	Value per ton c.i.f. London.	Remarks.
1	Difficult to sell owing to mixed size.	If graded the small beans would fetch £8 5*s*., the larger as for No. 2. If sold here would have to be graded.
2	£15–£16	Very good colour. If small ones graded out, the large would fetch £19.
3	Unsaleable	Colour bad.
4	£8 5*s*.	These are Lima type, for which the Continent and United States are better markets than the United Kingdom.
5	£7 10*s*.	
6	£7 10*s*.	
7	£6 5*s*.	

The above prices were quoted with standard commercial grades of beans at the following values :

Madagascar	£19 10*s*.
Ohtenashi	£8 5*s*.
Rangoon White . . .	£6 5*s*.–£6 10*s*.

(2) The second firm reported on the beans as follows :

Sample No.	Value per ton c.i.f. London.	Remarks.
1	£9 10s.	With Madagascar beans at £19. Very variable in size. Might be graded into two grades : the larger beans would then fetch about £12 and the smaller £8. The sample as it stands would be more difficult to sell than No. 2.
2	About £15	With Madagascar beans at £19. Could be graded with advantage.
3	—	Because of the yellow markings would be very difficult to sell, and no value could therefore be given. Recommended that this variety should not be offered on the United Kingdom market. Suggested that the yellow markings might be due to the beans not having been well harvested. If the beans were free from yellow they would be worth about £7 with White Rangoon at £7 2s. 6d.
4	£8	With Rangoon White at £7 2s. 6d. and Ohtenashi at £8.
5	£7 10s.	With Rangoon White at £7 2s. 6d. and Ohtenashi at £8.
6	£8	With Rangoon White at £7 2s. 6d. and Ohtenashi at £8.
7	—	See No. 3.

It will be seen from the foregoing valuations and remarks that with the exception of No. 3, and possibly No. 7, commercial consignments of the beans represented by the present samples would be saleable in the United Kingdom or on the Continent of Europe, and that in the case of Samples Nos. 1 and 2 the large beans, if separated, would be of considerably higher value than the remainder.

It was pointed out to the authorities in Nigeria that if steps are taken to produce any of the present beans in commercial quantities for shipment, it would be desirable to prevent as far as possible any deterioration in size or colour. It would also be advisable to investigate the feasibility of growing the more valuable strain of Madagascar beans represented in Samples Nos. 1 and 2 without any admixture or hybridisation with the Lima type, as if this could be done a considerably higher market value would result.

Beans from Southern Rhodesia

Five samples of beans forwarded by the Chief, Division of Plant Industry, Salisbury, were received through the

Director of the Royal Botanic Gardens, Kew, in January, 1931.

Four of the samples were stated to represent the principal varieties of haricot beans tested on the experiment stations of the Department of Agriculture ; the remaining sample consisted of Tepary beans (*Phaseolus acutifolius*). They were as follows :

" *Algerian White Bean.*"—This sample consisted of beans of slaty-cream colour, free from " yellow eye " and weathering marks. They were from $\frac{5}{16}$ to $\frac{1}{2}$ inch long and $\frac{1}{4}$ to $\frac{3}{8}$ inch broad. Two distinct shapes were present : one a well-rounded, oval bean, the other relatively flat and angular ; the former predominated. All the beans were plump, well-grown and in good condition, but the colour, though uniform, was poor, and in size and shape the beans showed a large and unsatisfactory variation.

" *Canterbury White Bean.*"—These beans were of cream colour, with a slaty tint, and were free from " yellow eye " and practically free from weathering marks. They were from $\frac{9}{16}$ to $\frac{11}{16}$ inch long and about $\frac{5}{16}$ inch broad. They were all plump and generally long and rounded, but showed some variation in shape. The colour was fairly good, but the shape did not conform to that demanded in the United Kingdom market.

" *Red Canadian Wonder Bean.*"—This sample consisted of dark brownish-red beans, $\frac{5}{8}$ to $\frac{3}{4}$ inch long and $\frac{1}{4}$ to $\frac{5}{16}$ inch broad. They were long, slender and rounded, with a general tendency to kidney shape. The beans were plump and in good condition, but unsuitable for sale in the United Kingdom for human consumption owing to their colour.

" *Natal Sugar Bean.*"—These were yellowish-brown beans with red markings. They were $\frac{7}{16}$ to $\frac{9}{16}$ inch long and $\frac{1}{4}$ to $\frac{3}{8}$ inch broad, rounded oval in shape and plump. They were too highly coloured to be saleable for human consumption in the United Kingdom.

" *Tepary Bean.*"—These were mostly brownish-cream beans, but some were slaty-cream. They were free from " yellow eye " and weathering marks, but the colour was poor. The beans were from $\frac{1}{4}$ to $\frac{3}{8}$ inch long and about $\frac{1}{2}$ inch broad. They were of rounded oval shape, plump

and in good condition. Apart from the unsatisfactory colour these beans would be unsuitable for the United Kingdom market on account of their small size.

The beans were submitted to a firm of importers in London, who furnished the following observations regarding their quality and value.

Algerian White.—This is the only one of the present set that would be saleable in the United Kingdom for human consumption. The sample, however, is not of satisfactory quality, as the colour is dark and the beans are mixed in shape and size. They are, however, somewhat better in colour than Rangoon White beans, and their approximate value would be £8 10s. c.i.f. London with Ohtenashi beans at £10 and hand-picked Rangoon White beans at £7 10s. per ton (May, 1931). They would realise a slightly higher price if they were more uniform in size, and considerably more (say another £1 per ton) if the colour could be improved to a good white.

Canterbury White.—These beans are not of the desired shape for the United Kingdom market, but would be saleable on the Continent of Europe.

Red Canadian Wonder and Natal Sugar Beans.—There is no market in the United Kingdom for coloured beans for human consumption, but consignments of these beans could be disposed of for feeding cattle or poultry at about £4 per ton c.i.f.

Tepary Beans.—These are too small for the United Kingdom market, but they should be saleable either in Canada or on the Continent of Europe.

In connection with the above valuations, the importers pointed out that the price of beans at the time was abnormally low.

Enquiries were also made to ascertain whether the Natal Sugar beans and possibly the Red Canadian Wonder beans could be utilised for the preparation of soup powders or similar food products, for which purposes the external colour might be no disadvantage. Firms manufacturing such preparations who were consulted stated, however, that such beans were not suitable for their purposes. Their reports confirmed the views of the importers that there would be no appreciable market in the United Kingdom

or on the Continent of Europe for such beans for human consumption.

It will be seen from the preceding market reports that the Algerian White bean is the only one of these five samples which would be saleable for human consumption in the United Kingdom, and that even in this case the quality is below that of the best types of similar beans already on the market.

The Canterbury White and Tepary beans would not be acceptable in the United Kingdom for human consumption owing to their shape or size, and the Red Canadian Wonder and Natal Sugar beans are unsuitable on account of the colour of the seed-coat. Consignments of these four types of beans could be disposed of in the United Kingdom market for cattle-feeding purposes, but would only realise a low price. A better market might possibly be found for the Canterbury White and Tepary beans on the Continent of Europe.

Tepary Beans from South Africa

A sample of Tepary beans (*Phaseolus acutifolius*) was forwarded to the Imperial Institute by the Empire Cotton Growing Corporation in October, 1929.

The beans had been received from the Corporation's Cotton Breeding Station at Barberton, where they had been grown as a rotation crop with cotton.

The sample consisted of small, oval, ivory-white beans, coated with a deposit of pinkish earth. The weight of 100 beans was 13·4 grammes.

The beans were analysed with the following results, which are shown in comparison with the corresponding figures obtained at the Imperial Institute for a sample of Tepary beans from Burma (this Bulletin, 1916, **14**, 155).

	Present Sample. *Per cent.*	Sample from Burma. *Per cent.*
Moisture	10·3	12·0
Crude proteins	24·1	23·6
Fat	0·9	1·3
Carbohydrates, etc. (by difference)	58·6	57·2
Crude fibre	3·1	2·7
Ash	3·0	3·2
Nutrient ratio	1 : 2·5	1 : 2·5
Food units	121	119

The beans were found to be free from cyanogenetic glucosides.

The foregoing results show that the beans are similar in composition to the Tepary beans from Burma previously examined.

The beans were submitted to two firms of importers in London who furnished the following reports (November, 1929):

(1) " These beans are not unknown on the market, but no business has been done in them. They are stained with red earth, and the cost of cleaning would be about £2 per ton after arrival here. We estimate the value as they stand at the moment at £18 per ton, c.i.f. London. They would have to be packed in strong jute bags, of 80 to 112 lb. for preference, but this is not imperative, and any weight up to 2 cwts. would be taken although large-weight bags are not liked. We could, no doubt, find a regular market for them, and would suggest a consignment of say 20 tons so that we could introduce them to this market, to be sold by us on a commission of 1 per cent. After once introducing them, should they turn out satisfactory as regards cooking, after having been cleaned, we could do a regular trade in them."

(2) " These beans are known on our market, and at times of scarcity have sold very freely, and if they were here now, owing to the great scarcity of beans, they would be worth, in the state which you submit sample, approximately 21*s*. per cwt. c.i.f. London, there being an abnormal demand for all beans owing to the great scarcity, until the new crop arrives from Eastern Europe and Japan. It is very difficult to give a nominal value in view of values of beans being so upset during these last two or three years. This, however, we consider, should be £12 to £13 per ton c.i.f. The sample which you have sent to us shows the beans covered with red earth ; this is caused, we understand, owing to the fact that the beans are thrashed on the ground, and before the beans can be used for human consumption this red earth must be washed off, and the cost in London is approximately 1*s*. 6*d*. per cwt. In further reference to the prices, we think that you might consider the value will vary between the two figures

that we have mentioned, the market being the ruling factor."

Tepary beans have a high food value and compare very favourably from this point of view with haricots, lentils and peas. The beans represented by the present sample should be readily saleable in the United Kingdom, but it will be observed from the reports quoted above that their value is reduced if they are covered with earth as in the present case.

It was suggested to the Empire Cotton Growing Corporation that the crop might be grown on a sufficient scale to enable a trial consignment of about 20 tons to be shipped to the Imperial Institute, for disposal to the firm of importers who have offered to place them on the market with a view to the development of a regular trade.

"Seven-Year Beans" from Basutoland

A sample of beans forwarded by the Agricultural Officer, Basutoland, under the name "Seven-Year Beans," was received through the Royal Botanic Gardens, Kew, in June, 1932. They were stated to be derived from *Phaseolus coccineus* and this identity has been confirmed at Kew. The bean is said to be a good cropper, a yield of 15 bags of 200 lb. from 2½ acres having been recorded. The sample was forwarded in order to ascertain the market value of the beans and particularly their suitability for canning with tomatoes.

The beans were of medium size, mostly about ¾ inch long by ⅜ inch broad, plump and of ivory-white colour. A few had brown patches.

Reports on the beans were obtained from firms in London, Liverpool and Glasgow.

(1) Two firms of importers in London who were consulted considered the sample to resemble "white runner" beans, which are now quoted in London at £16 to £20 per ton (June, 1932). They stated, however, that they were considerably smaller than the beans of that class usually sold in London and would therefore be difficult to dispose of on this market. It was considered that there would probably be an outlet for the beans in Glasgow and Liverpool, or on the Continent. Improvement could be

effected by the removal of "stained" beans (i.e. those showing brown patches), a few of which were present in the sample.

(2) The Secretary of the Chamber of Commerce in Liverpool furnished a report on the beans in which it was stated: "The sample of Basuto beans may be described as Medium Haricot beans and would, probably, find a good market at 11*s.* 6*d.*–12*s.* per cwt., c.i.f. Liverpool, say up to a few hundred tons, which, of course, depends upon the price. They should be packed in 1 cwt. bags net weight; Hessian bags would suffice."

He expressed the opinion that the present is a very opportune time for working up a business in these beans in competition with beans from foreign sources and he suggested that the best means of disposing of the greatest quantities would be by the appointment, in Liverpool, of an agent of the shippers in Basutoland.

(3) A firm of importers in Glasgow, who were introduced to the Imperial Institute by the Glasgow Chamber of Commerce, forwarded the following report on the beans.

"The beans are clearly an edible bean of the haricot type, but they are smaller than either the Galicians or Chileans which we have been handling.

"The boiling gives very excellent results. They take considerably less time than the Chileans, the only drawback being that there is a black speck on the skin only, which detracts materially from their appearance, and good appearance is essential to our buyers. This is really the only thing we have against them. We consider them equal or slightly superior to Chilean Pallares, but inferior to Galicians.

"We put the value at 11*s.* per cwt. c.i.f. Glasgow, which is the last price we paid for Chileans. There is of course a duty against Chilean beans, which may not operate against beans shipped from Basutoland, but it would entirely depend upon the port of shipment. If grown in Basutoland they would naturally claim the Empire preference.

"We would say finally that we believe there will be a market for them at about this price, despite the slight drawback of skin discoloration."

In a covering letter to this report the firm stated :

" In competition with this there is a similar bean being grown in Rangoon, which is being offered here at 8*s.* 6*d.* per cwt., c.i.f. Glasgow, but it is not as good a bean as the Basutoland bean. Due allowance has been made for this in indicating that the price of the Basutoland bean is 11*s.* per cwt."

In view of the promising character of these beans the firm expressed a desire to be put in touch with shippers in order to place consignments on the Glasgow market.

With regard to the suggestion that the beans might be used for canning with tomatoes, firms who were consulted on this point stated that for such a purpose it is customary to employ either small beans like Japanese Ohtenashi, or large ones such as Madagascar butter beans, and they were of opinion that the present beans would not find any outlet in this direction.

It is clear from the above reports that there would be a good market in Liverpool and Glasgow for beans of the quality of this sample and the Basutoland authorities have been furnished with the names of firms in those cities who would be prepared to handle consignments, if commercial supplies of the beans become available.

TEA FROM NYASALAND—III

In continuation of the investigation of samples of Nyasaland tea recorded in previous numbers of this Bulletin (1931, **29**, 271 ; 1932, **30**, 263), six further samples were forwarded to the Imperial Institute by the Director of Agriculture in April 1932. They represented teas manufactured locally on an estate (designated as " D "), and it was desired to receive observations on their appearance, quality, liquoring properties and any faults in preparation which might be apparent. It was also desired to ascertain their commercial value on the United Kingdom market.

Three pairs of samples were submitted, representing respectively (A) a local jat, (B) an imported Manipuri jat and (C) a mixture of equal quantities of the two jats.

Each pair consisted of Broken Orange Pekoe and Broken Pekoe Souchong.

Description

The samples all consisted of black tea and weighed from 2½ to 3 lb. each. They were as follows :

A (B.O.P.) and A–2 (B.P.S.).—" From bushes grown from acclimatised local seed. Planted in February–March 1925."

B (B.O.P.) and B–2 (B.P.S.).—" From an imported Manipuri jat. Planted February–March 1925."

C (B.O.P.) and C–2 (B.P.S.).—" Composed of 50 per cent. of Local and Indian from the same gardens as A and B."

The following particulars were furnished regarding the preparation of the samples :

Samples A and A–2.

Withering.—Withered, 25 hours. Loss of moisture, 45 per cent. Temperature of Leaf Lofts : maximum 82° F., minimum 62° F. Spread, 1 lb. leaf per sq. yard.

Rolling.—The conditions of rolling were as follows :

	Average temperature of discharged leaf.
1st Roll, 30 minutes, no pressure	77°
2nd Roll, 30 minutes, very light pressure	81°
3rd Roll, 5 minutes, no pressure ; 15 minutes, medium pressure ; 10 minutes, no pressure	81°
4th Roll, 5 minutes, light pressure ; 10 minutes, heavy pressure ; 5 minutes, light pressure	80°
5th Roll, same as *4th* Roll	81°
6th Roll, same as *4th* Roll	80°

Average temperature of Rolling Room, 74° F. Humidity, 79 per cent.

Fermentation.—Leaf spread on cement beds. Fine bulk, 1¼ in. thick ; coarse bulk, 1¾ in. thick. Fine bulk fermented 3¼ hours from the commencement of rolling ; coarse bulk, 3¾ hours. Average temperature of Fermenting Room, 73° F. Humidity, 80 per cent.

Firing.—Done in two operations in Paragon Driers at temperatures of 200° F. and 185° F. Time taken in first operation, 15·6 min. ; in second operation, 15 min.

SAMPLES B AND B–2.

Withering.—Withered, 26½ hours. Loss of moisture, 44 per cent. Temperature of Leaf Lofts: maximum 82° F., minimum 62° F. Spread, 1 lb. leaf per sq. yard.

Rolling.—Times and pressures the same as for "A."

Average Temperature of Discharged Leaf

1st Roll	78°	*4th* Roll	79°
2nd Roll	79°	*5th* Roll	80°
3rd Roll	81°	*6th* Roll	80°

Average temperature of Rolling Room, 75·5° F. Humidity, 77 per cent.

Fermentation.—Spread the same as for "A." Fine bulk fermented 3½ hours from the commencement of rolling; coarse bulk, 4¼ hours. Average temperature of Fermenting Room, 73° F. Humidity, 79 per cent.

Firing.—Two operations. At 200° F. for 14·8 min., at 185° F. for 15 min.

SAMPLES C AND C–2.

Withering.—Withered, 27 hours. Loss of Moisture, 46 per cent. Temperature of Leaf Lofts: maximum 82° F., minimum 62° F. Spread, 1 lb. leaf per sq. yard.

Rolling.—Times and pressures the same as for "A."

Average Temperature of Discharged Leaf

1st Roll	78°	*4th* Roll	78°
2nd Roll	80°	*5th* Roll	80°
3rd Roll	79°	*6th* Roll	82°

Average temperature of Rolling Room, 76° F. Humidity, 76 per cent.

Fermentation.—Spread the same as for "A." Fine bulk fermented 3½ hours from the commencement of rolling; coarse bulk, 4 hours. Average temperature of Fermenting Room, 73·5° F. Humidity, 79 per cent.

Firing.—Two operations. At 200° F. for 15 min., at 185° F. for 15 min.

The weather conditions for all the samples were as follows:

Dull misty morning, with a slight drizzle, when the leaf was put on the tats. Maximum temperature, 70° F.; minimum, 59° F. Humidity, 88 per cent. at 11.30 a.m.

It was further stated that:

(*a*) Withering is uncontrolled and depends on weather conditions. The weather conditions during manufacture were regarded as favourable for the time of year.

(*b*) The reason for including the samples of B.P.S. is on account of the rolling. The leaf is sifted after each roll and the fine leaf from which the B.O.P. is obtained is removed to the fermenting room after each sifting. The B.P.S. leaf has received the full six rolls.

(*c*) The speed of the rollers was in all cases 54 revolutions per minute.

Results of Examination

The teas were examined with the following results:

	A. B.O.P.	A–2. B.P.S.	B. B.O.P.	B–2. B.P.S.	C. B.O.P.	C–2. B.P.S.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	8·3	8·5	8·7	8·7	8·5	8·6
Expressed on the moisture-free tea:						
Caffeine	4·22	4·01	4·45	4·38	4·33	4·06
Tannin	15·8	14·8	16·2	15·4	16·3	14·4
Hot-water extract	51·2	48·9	53·2	52·1	52·9	52·1
Total mineral matter	5·78	5·22	5·65	5·43	5·56	5·67
Ash, soluble in water	3·93	3·62	3·94	3·76	3·62	3·92
Ash, insoluble in water (less silica)	1·54	1·44	1·45	1·52	1·59	1·60
Silica	0·31	0·16	0·26	0·15	0·35	0·15

The foregoing results show that the six teas were all of normal composition. It will be observed that the B.P.S. samples all contained slightly less caffeine, tannin and hot-water extractive matter than the corresponding samples of B.O.P. leaf.

Commercial Valuation

The teas were submitted to (*a*) the brokers and (*b*) the importers who described and valued the three samples from the same estate dealt with in the last report (this Bulletin, 1932, **30**, 266). Both firms were furnished with

the particulars supplied by the Director of Agriculture regarding the preparation of the samples. Their reports were as follows :

(a) *Brokers.*

" *Dry Leaf.*—The ' A ' B.O.P. has the best tip ; they are all three, however, useful grades. In the case of the B.P.S., in leaf all three are of equal value.

" *Liquors.*—With regard to cup quality, the ' B ' samples have the most pungent cup, the ' A ' samples being softish and lacking in this respect. The blend of the two, however, makes a useful tea.

" *Infused Leaf.*—Is rather light and inclined to greenness.

" We should like to see samples which have had a rather longer fermentation, say 4 hours or 4½ hours at this temperature."

The firm assigned the following values to the samples (July 29, 1932) :

	per lb		per lb
A . .	1s 4·5*d*	B–2 . .	6½*d*
A–2 . .	6½*d*	C . .	1s. 2·3*d*.
B . .	1s. 0·1*d*.	C–2 . .	6½*d*. to 6¾*d*.

(b) *Importers.*

" We have much pleasure in reporting on the six samples as follows :

" *A.*—The leaf is even and well made with a considerable amount of bright-coloured tip. The tea has an even-coloured bright infusion, and the liquor is a little thin and bright but lacking in flavour. Approximate value (July 29, 1932), 1*s*. 8*d*. to 1*s*. 10*d*. per lb.

" *A–2.*—Has a black rather ' shelly ' leaf with a similar liquor and infusion to A. Approximate value, 6½*d*.

" *B.*—The leaf is a good size but is more irregular and mixed than A ; has less and paler coloured tip. The infusion is even coloured but a little greenish, and although the liquor has more colour than that of A, it is again lacking in flavour and of slightly inferior quality. Approximate value, 1*s*. to 1*s*. 2*d*.

" *B–2.*—Similar appearance to A–2 and has a similar liquor and infusion to B. Approximate value, 6¾*d*.

" *C.*—The leaf is very similar to that of B, but has a little browner background, and the tip is of a more golden colour, making the tea rather more desirable. The infusion and liquor, although slightly preferable to B, are not so good as A. Approximate value, 1*s.* 4*d.*

" *C–2.*—Leaf appearance similar to A–2 and B–2 and similar liquor to C. Approximate value, 6½*d.*

" In our opinion all six samples are quite suitable and saleable in the United Kingdom, and if the market was not so depressed we feel sure the teas would be well supported in public sale, for they are considerably superior to any Nyasaland tea selling at present."

The firms were consulted regarding the advisability or otherwise of mixing the jats as in the case of samples C and C–2, and replied as follows :

(*a*) The brokers stated : " In our opinion no harm will be done in mixing the two jats of leaf."

(*b*) The importers furnished the following observations :

" We are of the opinion that the previous remarks of our Technical Advisor regarding mixing of jats apply to the present case. The C samples are distinctly inferior to A and are only very slightly preferable to B. The mixture of A and B teas has therefore resulted in a tea much nearer B quality than A.

" The above remarks of course only apply to liquor and cup quality. From a leaf point of view the good appearance of A has improved the poor appearance of B, and from our valuations you will see that there is practically nothing to choose.

" It seems to us that the big factor to study is the eventual marketing value of the teas produced. Without question, the present poor prices of tea are mainly due to a terrific surplus of plain medium tea. Good tea is scarce and is fetching good prices. Would it not prove more advantageous to produce as much good tea as possible on the lines of A samples ? "

Remarks

From the foregoing reports it will be seen that the brokers and importers were in general agreement as to the

quality and value of the teas in the United Kingdom, but expressed rather different views regarding the desirability of mixing the jats.

WATTLE BARK FROM SOUTH AFRICA

I. Natal

The bulk of the wattle grown in Natal consists of black wattle (*Acacia mollissima*). This species, however, suffers severely from an insect pest known as the bagworm, and as the green wattle (*A. decurrens*) is relatively immune to attack, it is being increasingly planted. In order to ascertain the composition of mature and immature bark of green wattle in comparison with corresponding bark of the black wattle tree, samples of each were forwarded to the Imperial Institute by the Wattle and Timber Growers' Association of Natal in March 1932. It was also desired to ascertain the possibility of employing immature bark for the manufacture of extract.

The samples, which weighed about 30 lb. each, were as follows :

"*Mature Black Wattle,* 8 *years old.*"—Pieces of bark 38 in. in length and about $\frac{1}{8}$ in. thick.

"*Immature Black Wattle,* 50 *per cent.* $2\frac{1}{2}$ *years old and* 50 *per cent.* 4 *years old.*"—Pieces from $1\frac{1}{2}$ to $2\frac{1}{2}$ ft. long and $\frac{1}{16}$ to $\frac{1}{8}$ in. thick.

"*Mature Green Wattle,* 50 *per cent.* 11 *years old and* 50 *per cent.* 6 *years old.*"

"*Immature Green Wattle,* 50 *per cent.* $2\frac{1}{2}$ *years old and* 50 *per cent.* 4 *years old.*"

These two samples consisted of pieces 4 ft. long and from $\frac{1}{16}$ to $\frac{1}{4}$ in. thick.

The samples of black wattle were greyish-brown externally, the inner bark being reddish-brown. The outer and inner barks of the samples of green wattle were slightly darker.

The samples were chemically examined with the following results :

	Black Wattle.		Green Wattle.	
	Mature.	Immature.	Mature.	Immature.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	12·9	11·8	11·7	11·1
Insoluble Matter	38·9	41·1	39·5	47·8
Extractive Matter (non-tannin)	12·6	13·6	10·7	11·6
[1] Tannin	35·6	33·5	38·1	29·5
Ash	2·8	2·6	1·9	1·9
[2] Tintometer Readings :				
Red	4·1	3·1	4·4	4·3
Yellow	6·2	4·6	6·8	6·5

[1] *Analysis made by the Official International Method of Tannin Analysis (Hide Powder Batch C.*3). *Riess method of filtration.*

[2] *Determined for a solution containing* 0·5 *per cent. tannin in a* 1 *cm. cell.*

The leathers furnished by the green wattle barks were not quite so close-grained as those produced with the black wattle samples, and were of a decidedly pinker tint.

These results show that the samples of mature bark of each variety of wattle contained more tannin than the immature bark ; the difference in the case of the green wattle being very marked. The amount of tannin in the mature green wattle bark was above the average met with in the black Natal wattle bark of commerce.

Black Wattle

Mature bark.—The figure of 35·6 per cent. of tannin in the present mature black wattle bark, from 8-year-old trees, is in agreement with the amount (34·5 per cent.) given by C. O. Williams (School of Agriculture, Cedara) as the average for bark from trees of this age. Such bark would represent commercial consignments of good quality, the average tannin content of which is about 34 per cent.

Immature bark.—The amount of 33·5 per cent. of tannin in the sample of immature black wattle bark, stated to consist of equal quantities from trees 2½ and 4 years old, is very satisfactory, and equal to that of the commercial bark of good quality received in recent years from Natal. Such immature bark should therefore be acceptable to buyers in the United Kingdom. Williams, however, records figures of both 33·3 and 26·3 for samples of bark from 2½-year-old trees, and 28·1 for 4-year-old trees. The figure of 33·5 per cent. for the present sample is thus considerably higher than would be expected, and should

not be regarded as normal for bark of this age until a greater number of representative samples have been examined.

The colour and texture of the leather furnished by this sample were equal to that of the leather made with the sample of mature black wattle bark.

For extract-making, immature black wattle bark of similar composition to the sample would be as satisfactory as the ordinary bark of commerce.

Green Wattle

Mature bark.—The sample of mature green wattle bark, collected in equal quantities from trees 11 and 6 years of age, contained as much as 38·1 per cent. of tannin. It may be pointed out, however, that 11 years is a late age for stripping, and the high percentage of tannin is no doubt due to the presence of this old bark. Williams gives the average figures for bark from green wattle trees of 6 years as 30·4 and from trees of 9 years as 37·0 per cent., but no previous figures for bark from 11-year-old green wattle trees are available. Bark of the composition of the present sample would undoubtedly be considered of excellent quality by this market, but it seems reasonable to doubt whether supplies on a commercial scale could be maintained at this standard.

The analysis shows the bark to be suitable for extract-making, but a disadvantage attaching to this sample is that it yielded leather of a deeper pink colour than that furnished by black wattle bark. Whether any great importance is to be attached to this point, and whether the fault could be easily compensated, is a matter for tanners to decide.

Immature bark.—The sample of immature green wattle bark, from trees of 2½ and 4 years of age in equal proportions, contained 29·5 per cent. of tannin. Williams gives 23·5 as an average for bark from 3-year-old green wattle, and 29·0 for bark from 4-year-old trees, and the mean for a mixed sample, such as the present one, would thus be only 26·25 per cent. On this basis of comparison, therefore, the present sample is above the average. It is, however, considerably below the sample of mature green

wattle bark in tannin content, and inferior to the ordinary black wattle bark of commerce, for which, as previously mentioned, 34 per cent. of tannin may be taken as an average.

Bark similar to the present sample would be inferior to ordinary black wattle for extract-making, as the yield of a 30 per cent. tannin extract would be less, whilst involving a greater cost of labour.

Remarks

The present investigation would have yielded results of greater value had the bark from trees of different ages been kept separate, and not mixed as in the case of three of the four samples submitted.

In order to establish the amount of tannin generally present in black and green wattle barks of different ages it would be necessary to investigate further samples. Each sample should consist of representative bark from several trees of *the same age*, and be accompanied by full details of collection, including the district of growth. It would be of value to know the number of trees from which each sample of bark is obtained, as the greater the number the more representative and valuable are the results. It would also be of interest to know the positions on the trees from which the barks are stripped, since obviously a 6-year-old tree (for instance) is not six years old in all its parts, and the bark from the base of the trunk is older than that from near the top and that from branches.

II. Southern Rhodesia

A sample of black wattle bark was forwarded to the Imperial Institute by the High Commissioner for Southern Rhodesia, in September 1932. The material had been received from the Department of Agriculture, and it was stated that 100 tons of the bark were available for sale in Rhodesia.

The sample weighed 14 lb., and consisted of small chips and pieces of bark up to 4 in. in length. Externally the bark varied from greyish-brown to reddish-brown, whilst the inner bark was generally a uniform dark reddish-brown.

The bark was examined with the following results

	per cent.
Moisture	11·9
Insoluble Matter	46·8
Extractive Matter (non-tannin)	8·1
[1] Tannin	33·2
Ash	1·9
[2] Tintometer Readings:	
Red	4·7
Yellow	8·7

[1] *Analysis made by the Official International Method of Tannin Analysis (Hide Powder Batch C.*3).

[2] *Determined for a solution containing* 0·5 *per cent. of tannin in a* 1 *cm. cell.*

The bark yielded a fairly soft, close-grained, pale pinkish-brown leather of firm texture.

The foregoing results show that the present sample of wattle bark is of satisfactory composition, but is was of unattractive appearance owing to faulty drying. The amount of tannin closely approximates to the average quantity (34 per cent.) found in the black wattle bark exported from Natal, and the leather produced is of satisfactory quality. It is evident that bark of good commercial quality could be obtained if more care were exercised in the drying.

ARTICLES

REPORT ON THE JAVA FIBRE INDUSTRY

By E. F. S. Shepherd

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The following report has been furnished to the Imperial Institute by the Colonial Office, and is reprinted here by kind permission of the Mauritius Government.

In accordance with instructions cabled to me in Soerabaya by His Excellency the Governor, and received by me on January 26, 1931, I carried out the required investigation on the Java Cantala fibre industry, and now have the honour to submit the following report.

From information given to me in Soerabaya and Pasoeroean I gathered that the two chief fibre-producing organisations in Java were the Handelsvereeniging Amsterdam in East Java, and the Maatschappij ter Exploitatie

der Pamanoekan en Tjiasemlanden, with headquarters at Soebang, West Java.

I was given a letter of introduction to Dr. C. E. Van der Zyl, of the Technical Staff of the West Java Fibre Company, the Maatschappij ter Exploitatie der Pamanoekan en Tjiasemlanden, at Soebang. This gentleman expressed his willingness to do all he could to get me permission to visit the Company's fibre estate and factory. He introduced me to Mr. Denham, the General Manager of the Company, who very generously and unhesitatingly gave the necessary permission. I was most cordially received at the Soekamandi fibre estate by the Manager, Mr. Fletcher, from whom I received the utmost hospitality. From him and from Mr. Rensink, the Assistant Manager, Mr. Dendoop, in charge of field experiments, the Chief Engineer of the Factory, and Mr. Crone, Factory Manager, I was able to obtain the information required by His Excellency the Governor.

I was taken through the fields by Mr. Rensink; I spent an hour in the laboratory of Mr. Dendoop, and was conducted through the factory by Mr. Crone, who explained the various processes and, assisted by the Chief Engineer, supplied me with information on the machinery employed.

At Soekamandi I was told that the type of fibre exported in by far the largest quantities from Java is Sisal. The Cantala market is a very restricted one. There is a much greater world demand for Sisal. For this reason, and also for the reason that the Cantala plant is much more liable than Sisal to certain diseases which result in a reddened fibre, and that Cantala is more difficult and thus slightly more expensive than Sisal to harvest, on account of the more spiny nature of the former, the Soekamandi estate management is in future planting no more Cantala, but is devoting all the land to Sisal only.

The cultural and factory operations for the production of both fibres are the same, except that, owing to the fact that the great majority of Cantala plants produce no flowering poles, this crop is almost entirely propagated by means of suckers, whereas bulbils produced on the flowering poles are largely employed in the propagation of Sisal. But this, of course, is only a very minor difference.

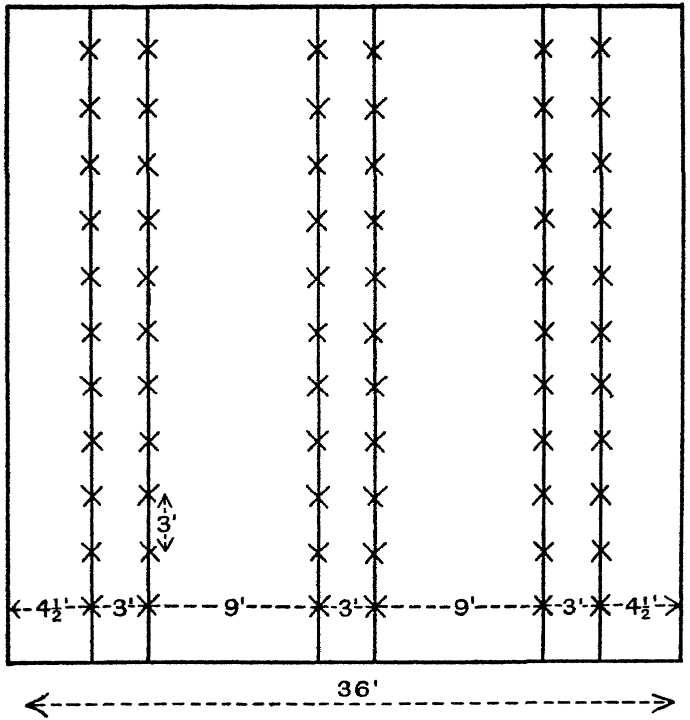
Cultural Methods.—The suckers, or bulbils, or both as the case may be, are planted in nursery beds, where they remain one year. They are then transplanted to the fields. The fields are split up into blocks, 36 ft. wide and as long as the width of a field. Each block is bounded on either side by a drain about 18 in. in width and 2 ft. deep. These drains lead to a main drain running along the side of each field. The surface of each block slopes very gradually from the middle down to the edges adjoining the drains. The plants from the nursery beds are set out in rows according to either of the methods illustrated in the diagrams as shown on facing page.

Method I was formerly almost entirely used, but is now being replaced by Method II, which facilitates cultivation around each plant, particularly after the plantation is one year old.

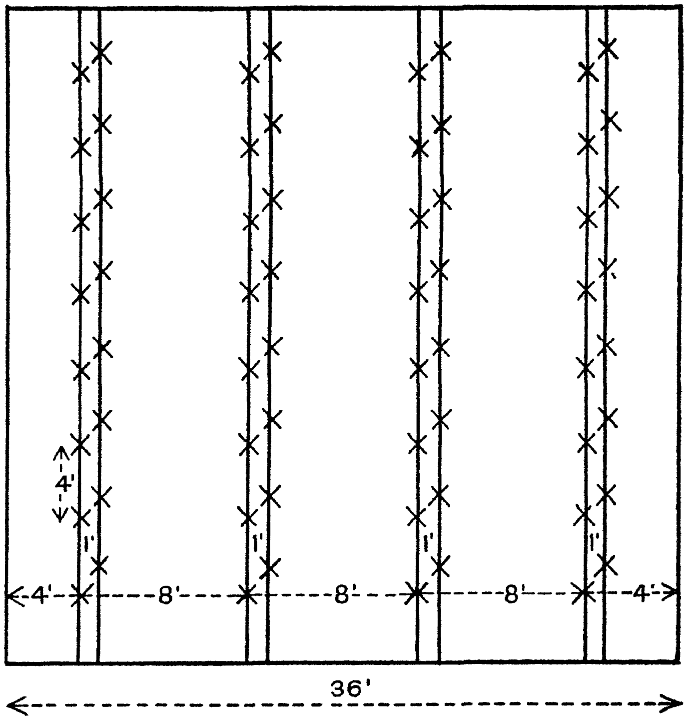
Best results are obtained by irrigating the field, before planting, with the waste water containing pulp running from the decorticators in the factory. This thoroughly moistens the land and supplies organic matter.

Each plant, on being set out in the field, is bound to a short bamboo stick pushed into the ground close to it to prevent its being blown over before it takes root.

Harvesting of the ripe leaves commences when the plantation is about fourteen months old, and continues for about seven years. When the flowering poles are still immature—some time before the flowers appear—they are cut off at a point about 4 ft. above the crown of leaves. This is to prevent transference of food from the leaves to the pole for the production of flowers and the maturing process. The cutting of the poles results, therefore, in the subsequent harvesting of thicker leaves with stronger fibre than would otherwise be the case. One crop of leaves is obtained after the cutting of the poles. Bulbils are readily formed in the axils of the rudimentary leaves on the severed poles. The last crop of leaves is taken when about 40 per cent. of the Sisal plants have "poled" and, in the case of Cantala, when the plants have produced a succession of short leaves (forming a rosette), which remain short even when mature, i.e. leaves which never attain the length of a normal leaf produced by an actively growing



METHOD I.—Plants 3 ft. apart in the rows.



METHOD II.—Plants 4 ft. apart in the rows.

plant. This is a peculiarity of the majority of Cantala plants, instead of the poling habit characteristic of Sisal and other closely related fibre plants, and is a sign that vegetative activity is coming to an end. Two crops of leaves are obtained each year, the yield being 1¼ to 2 tons of fibre per acre per annum. No irrigation is practised subsequent to the preliminary one prior to planting.

Each year potassic and phosphatic fertilisers are applied at the rate of about 60 kilos. of potash (K_2O) and 40 kilos. of phosphate (P_2O_5) per acre for Sisal, and the same amount of phosphate and half the amount of potash for Cantala, which is found to possess about half the potash requirements of Sisal. Of course the quantity of each fertiliser applied per acre must vary according to the type of soil in which the plants are growing.

There is no rotation practised at Soekamandi. After the removal of the remains of the old plantation the field is thoroughly irrigated with waste water from the factory, and replanted to Sisal or Cantala as the case may be.

Grading of leaves at harvest time.- After cutting, the leaves are graded in the field according to length.

Leaves above 1 metre in length are placed in grade A.
Leaves between 75 cms. and 1 metre are placed in grade B.
Leaves between 50 cms. and 75 cms. are placed in grade C.

Broken and diseased leaves are graded X, Y and Z instead of A, B and C, according to length, those above 1 metre long being placed in X grade, those between 75 cms. and 1 metre long in Y grade, and those between 50 and 75 cms. long in Z grade.

The immature leaves towards the apex of mature plants are also harvested and placed in a separate grade.

Fibre extraction.—The leaves on arrival at the factory are placed on endless-chain carriers, which convey them to the decorticators, Corona No. 2. In these decorticators the leaves are drawn through two narrow passages, each bounded by a rapidly revolving solid wheel, with projections on its circumference, and a smooth metal surface. The two wheels are on opposite sides of the machine, and

revolve in opposite directions. In its passage between these wheels and the metal surfaces each leaf is scraped and the soft tissues removed, first along one half and then along the other. The fibres are washed immediately after each scraping process by a strong jet of water, which removes effectively the cortical tissues. This water, containing broken bits of fibre and pulp, is then led away in channels from the machines.

The fibre, on passing from the decorticators, is placed in centrifugal machines, where it is further washed by means of a jet of water which plays on the fibre for three minutes after the machine has been set in motion. The machines continue running for six minutes after the jets of water have been stopped. This removes excess of water from the fibre.

On completion of the washing process the fibre is dried in large drying chambers through which steam pipes pass. Each drying chamber is also provided with a fan for the purpose of keeping the hot air in circulation.

The dried fibre is then beaten by hand labour on wooden bars supported about 3 ft. above the ground. This operation frees the fibre from the remnants of cellular tissue adhering.

The fibre is then graded and baled.

Grading of fibre.—In Java the fibre is graded into nine classes as under :

A, B and C are white fibres of over 1 metre, between 75 cms. and 1 metre, and between 50 and 75 cms. in length respectively.

X, Y and Z are graded in an exactly similar manner according to length as are A, B and C, but consist of reddened fibres.

D consists of what are known as " beatings," being stray fibres which fall on the floor during the beating process.

L consists of fibres of any length which are considered to be too red to be included in either X, Y or Z.

There is another grade known as " tailings," which consists of short ends produced in the process of trimming the tufts of fibre during the grading operation.

The fibre from the immature leaves referred to in the

notes on the harvesting process is graded separately and classified according to length and colour as in the case of the mature fibre, but described as "young."

Comparison between Sisal and Cantala in yield of fibre per weight of leaf. - Notwithstanding the fact that about 27 per cent. of the fibres in a Cantala leaf are broken in the decorticating machines, this plant yields about 1 per cent. more commercial fibre from a given weight of leaf than Sisal. Nevertheless, as already stated, the Cantala is being put out of cultivation on account of restricted demand for this class of fibre, and the fact that it yields a greater percentage of red fibre than does Sisal.

Motive power.—The refuse from the factory and the field is used as a fuel to generate steam, which is converted into electric power for driving the factory, but, as this provides only a part of the requisite power, the balance is obtained from a neighbouring electric supply station.

Cost of production.—At Soekamandi the fibre is produced at a cost of about £10 15*s.* per ton loaded on the ship. This includes field, factory and transportation costs, to which must be added depreciation and overhead costs. The factory costs are about £2 10*s.* per ton approximately. Field and transportation costs amount, therefore, to approximately £8 5*s.* per ton.

According to the manager of the estate, the difference in costs of production of Cantala and Sisal fibres respectively is very small, and has not been calculated at Soekamandi. The factory costs are the same for both fibres, but field costs are slightly higher in Cantala production.

Notes on machinery. - The plant employed is manufactured by the following firms :

Decorticators : Krupp, Magdeburg, Germany (Corona No. 2).

Centrifugal machines : Crosslin-De Haitre, Paris.

Drying chambers : Bernard Schilde, Berlin.

Baling presses : John Shaw & Sons, Ltd., Salford, England. (The presses at Soekamandi were worked by hydraulic power, and could exert a pressure of 2 tons per square inch.)

Rollers used for pressing of waste fibre in production of fuel : Geo. Fletcher & Co., Ltd., Derby and London.

UNVULCANISED RUBBER POWDER

By G. Martin, B.Sc., A.I.C., F.I.R.I.

[The following account of experimental work conducted at the Imperial Institute by the Research Staff associated with the London Advisory Committee for Rubber Research (Ceylon and Malaya) has been published in the *Bulletin of the Rubber Growers' Association* as an interim Report in connection with the programme of investigation of the Rubber Growers' Association Technical Research and Development of New Uses Committee. It is reprinted here by kind permission of the Association.]

One of the difficulties in extending the use of rubber is that it has to meet competition from cheaper but mostly inferior materials. Although rubber is eminently suitable for many purposes for which it is not at present extensively used, such as road surfacing, floor and wall coverings, etc., experience has shown that in spite of the low price of the raw material, there is considerable difficulty in producing a manufactured product to compete in price with alternative materials.

Ever since the early days of the rubber manufacturing industry it has been necessary to use heavy and expensive machinery to mix the raw rubber with compounding ingredients, to mould it to shape and to convert it into a satisfactory vulcanised product. The cost of these operations is high relative to that of raw rubber. Consequently cheap raw rubber is not as helpful as the grower would desire in promoting the production of cheap rubber articles.

During recent years there have been continuous efforts by manufacturers to reduce production costs by breaking away from stereotyped manufacturing processes. The greatest success has been obtained by the use of latex in place of crêpe or sheet, thus eliminating the need for heavy machinery for mixing and moulding, as well as in some cases the need for expensive solvents. The use of latex has, however, introduced problems of its own and although the older methods of manufacture are still retained for most purposes, the experience gained with latex has led to the

introduction of new products, for which it is expected there will eventually be a considerable demand.

The use of latex in place of raw rubber is perhaps the most obvious method by which the need for heavy machinery in the rubber manufacturing industry may be eliminated, but other methods are under consideration. For example, a much softer rubber than crêpe or sheet would offer distinct advantages as regards the cost of manipulation and the possibility of producing a satisfactory rubber of this type is under investigation by various research organisations. Another method of eliminating the need for heavy machinery would be to prepare rubber in the form of powder so that it can be mixed with vulcanising and compounding ingredients merely by shaking, after which it can be pressed into moulds and vulcanised under pressure so that the particles amalgamate together to the shape required.

The idea of using rubber in powder form appears to have arisen during the last few years. In 1930 a patent was taken out by the Dunlop Rubber Co., Ltd., for preparing rubber powder by a chemical process from preserved latex which has been mixed with large quantities of zinc oxide, carbon black and other compounding ingredients (B.P. 327,451). Another Dunlop patent is for the preparation of rubber in powdered form in the presence of large quantities of albumen (B.P. 342,922). Dr. S. S. Pickles, in an article in the *India Rubber Journal*, November 2, 1931, p. 611, pointed out that "the older methods of mastication and mixing have the common drawback that they absorb a large amount of energy," and he enquired, "Is it too much to hope that one day we may be able to buy our rubber in the form of a fine dry powder?"

The Dunlop patents are for the preparation of highly compounded rubber in the form of powder, and are therefore only of indirect interest to the planter. The possibilities of uncompounded rubber in the same form are, however, of direct interest as new methods of preparation in the East may be involved.

There is, of course, little difficulty in producing raw rubber in the form of pieces the size of a pea. Manufacturers are only too familiar with the difficulties caused by

treating rubber on the mixing rolls with materials such as caustic potash solution or some softeners which on account of their greasy nature cause the rubber to break into small pieces. The staff of the Rubber Research Institute, Malaya, recently called attention to the similar effect of the lipin bodies which they have isolated from latex. The particles obtained in this way are, however, too large to be of practical value in the rubber industry, and on continuous milling they amalgamate to form coherent sheets. The rubber globules in latex have a diameter of about 1/5000 in., and in order to obtain the same intimate mixture of rubber and compounding ingredients as is obtained with compounded latex the rubber powder would probably have to consist of particles of less than 1/1000 in. diameter.

No process has yet been devised in which rubber is obtained in a dry granular condition consisting of particles similar in size to the globules in latex, but there are a number of recent processes by which uncompounded rubber can be prepared in the form of a fine dry powder consisting of particles which are so small that they can be mixed with sulphur and a limited quantity of finely divided mineral powders to form on vulcanisation what appear to be fairly uniform products.

According to a Dutch patent by Stam (No. 55,335) latex is mixed with dextrin, centrifuged, and sprayed in hot air (*J.S.C.I., Chem. and Indust.*, Sept. 23, 1932, p. 799). The adhesion of the particles (which occurs during the Hopkinson method of spraying latex) is claimed to be prevented by the dextrin. No information is available as to whether any steps are being taken to develop this process. Application for a British patent (No. 23,600) has been made by another Dutch inventor, de Schepper. Particulars of this process have not yet been published, but it is understood that it is also a spray process combined with a mechanical device for removing the rubber particles.

A chemical process of preparing rubber powder from latex has been devised by the staff in London of the rubber research organisations of Ceylon and Malaya, and is being developed by T. E. H. O'Brien, Director of the Rubber Research Scheme, Ceylon. A mechanical method of

preparing rubber powder from latex or dry crêpe has also been devised by the staff in London. Applications for British patents for these processes have been made (Nos. 3,198/32 and 11,717/32 respectively) in conjunction with the Rubber Growers' Association, but it is not proposed to place any restriction on the use of these processes.

The work in London at the moment is being concentrated on the mechanical process, and a special grant has been made by the Technical Research and New Uses Committee of the Rubber Growers' Association for the preparation of material for trial. A large number of samples have already been distributed to rubber manufacturers and other possible users. A quantity of the material is now available for the purpose and applications for samples should be addressed to the Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, S.W.7.

The particles obtained by this method are not uniform in size, but vary from 1/32 in. diameter to a fine dust. Even if the fine dust were separated from the coarser particles by sieving, the finest particles would still be much larger than the rubber particles in latex. Fortunately sulphur and a number of accelerators, anti-oxidants, colouring material, etc., are soluble in rubber, so that there is a wide range of materials, which after mixing with rubber powder by the simplest means, form on vulcanisation excellent products. Experiments have proved the general truth of this statement, but a systematic study of the compounding and vulcanising properties of rubber powder has not yet been carried out.

The principal difficulty in using any rubber powder is that when it is mixed with finely divided mineral powders, such as zinc oxide or carbon black, the powders coat the particles of rubber and interfere with their amalgamation during vulcanisation. The amount of mineral powder which can be incorporated with rubber powder without seriously interfering with the strength of the vulcanised product depends upon the size of the particles, temperature, pressure and rate of vulcanisation. As regards the rubber powder prepared in London, no difficulty is experienced with 5 parts of zinc oxide per 100 parts of rubber, using an

ordinary screw press and vulcanisation temperatures as low as 126° C.

For some purposes it is desirable to produce rubber powder in the form of particles with a diameter greater than 1/16 in., and no difficulty is experienced in producing such particles in the experiments made in London. When large particles are mixed with colours and vulcanised under pressure, artistic mottled effects are obtained which were hitherto unobtainable in the rubber industry. These mottled effects are definitely due to the heterogeneity of the vulcanised material.

Most of the experimental work in London has been carried out on the preparation of the rubber powder, and very little on its applications. It has been shown, however, that novel colour effects can be obtained by a rough distribution of rubber powders containing different colouring materials. In addition, powder can be scattered on to some fabrics which have not been treated with latex or rubber solution, and good adhesion obtained on pressing and vulcanising. Such a process might be useful in the manufacture of imitation leather cloths, book-binding materials, etc.

Another possible method of using rubber powder is in the manufacture of a type of sponge rubber with possibilities as regards mats, upholstery, etc. In this case the rubber powder is mixed with sulphur and accelerators, and also preferably with a little dilute latex and then vulcanised without pressure. Samples of sponge rubber obtained in laboratory trials are not so bulky as some types of sponge already on the market (1 gramme occupies 3 c.cs.), but the cost of manufacture from powdered rubber should be extremely small. Large-scale trials are being arranged in order to obtain some information as to the stability and general suitability of the material.

There are many other directions in which a use may be found for rubber powder, and a promising line of investigation is the direct chemical treatment of the powder. For instance, a soft rubber prepared by the oxidation of coarsely shredded rubber is now on the market (Ungar and Schidrowitz, B.P. 368,902). The small size of the particles in rubber powder and the large surface involved increase

the speed and improve the uniformity of oxidation. For the same reason the powder can be conveniently treated with water, steam or alkalis to remove proteins, etc., and so obtain rubber which is more suitable for the electrical and other industries where water absorption is of importance. Chlorinated rubber is used as a paint material for special purposes, and at present it is necessary to dissolve the rubber in a suitable solvent preparatory to chlorination. Rubber powder has the advantage that it can be chlorinated without using a solvent. In practically every case where it is desired to convert rubber into another product by chemical reaction, a granular condition offers distinct advantages.

There is still another direction in which rubber powder has advantages over crêpe and sheet, and that is the ease with which it can be mixed with liquids and viscous materials generally to form pastes which can be applied to surfaces and consolidated by a little pressure. Very few experiments have been carried out with a view to developing the commercial use of rubber powder for this purpose, but it can obviously be mixed with hydraulic cements, oxidised oils, latex, asphalt and a wide range of materials which are difficult to mix with crêpe and sheet. Vulcanised rubber crumb is already used in association with binding materials for some purposes, and unvulcanised rubber powder might be used for the same purposes with the additional advantage of plasticity and capacity to vulcanise. The scope of rubber powder in this direction is very wide, and its ultimate use must depend in every case upon the collaboration of experts outside the rubber industry.

Little information is available as regards the cost of producing rubber powder. It is claimed for one of the Dutch processes that it will prove more economical to manufacture than crêpe or sheet. Even if the manufacturing costs are nil it will probably cost more to deliver the powder at a local port for shipment abroad than either crêpe or sheet for the following reasons :

1. Manufacturing costs for crêpe or sheet are smaller than packing and local transport costs.—(*See* " Latex Preservation and Shipment," by R. O. Bishop and R. G.

Fullerton, *Rubber Research Institute of Malaya—Planting Manual* No. 4, 1932, Appendix, Table 3.)

2. Rubber powder without compression occupies three times the volume of a solid block of rubber of the same weight.

3. Great care must be taken to avoid massing during transit or storage, and this might necessitate packing in small cases.

4. Organic material in powder form constitutes a much greater fire risk than the same material in crêpe or sheet form.

In these circumstances the cost of cases must be high and the extra cost involved in local transport must exceed the cost of sheet manufacture. The cost of transport to Europe and America must be higher still.

The difficulties connected with transport can be overcome by preparing the powder from crêpe or sheet in the factories where it is to be used. This probably represents the cheapest method of obtaining rubber powder. However cheaply it can be made, and whether it is made from fresh latex in the East, or from dry rubber in Europe and America, it is necessary to assume that it will be at least slightly more expensive than crêpe or sheet. This will restrict the use of the powder for purposes where crêpe or sheet are now employed, but there are purposes for which the convenient form of rubber powder renders it of vital importance. These purposes may be summarised as :

1. Artistic mottled surfaces.
2. A new type of sponge.
3. Production of rubber-covered fabrics without solvent or latex.
4. Production of new types of material by chemical reagents.
5. Production of easily manipulated pastes which can be consolidated and vulcanised as required.

It is along these lines that developments in the use of the powder are likely to occur. The cost of the powder and the small extent to which it can be compounded will restrict its use in place of crêpe or sheet in rubber manu-

facture, but the facility with which it can be converted into new technical products is an advantage which should be of considerable value in extending the market for materials containing rubber.

GERANIUM OIL

(1) *Production in Algeria*

A GENERAL article on the cultivation of geranium and the production of the essential oil appeared in this BULLETIN (1929, **27**, 313). The following additional information with regard to the geranium oil industry in Algeria has been taken from an account contributed by Dr. Ernest S. Guenther to the *American Perfumer and Essential Oil Review* (1931, **26**, 545).

The variety grown in Algeria is stated to be *Pelargonium graveolens*, which has been cultivated in that country for about sixty years. Whereas in France geranium cannot survive the winter frosts and must therefore be planted afresh every spring, in the milder climate of Algeria, where the winter temperature averages about 10° to 12° C., it is grown as a perennial and lasts for about seven years. The plants attain a height of about 2½ ft. to 3 ft., and are very resistant to drought, although in dry periods the yield of oil is considerably reduced.

In the districts most suitable for geranium cultivation the soil is light and consists mostly of gravel and chalk, and plants grown on such soils appear to yield more oil than those grown on clay soils. Manures are not generally applied before the third or fourth year, sometimes not until the fifth year. Preference should be given to nitrogenous manures, and acid manures should be avoided. A considerable extension in the area devoted to geranium in Algeria took place in 1924–25 owing to the high prices then ruling for the oil, but with a subsequent fall in price and increased costs of production the industry has tended to diminish.

As a rule two cuttings are made each year. The first takes place between the middle of April and the end of

June, when the plants are in full bloom and their odour, originally somewhat lemon-like, has changed to a pronounced rose-like odour. The second cutting is taken during October and the first half of November, when the plants have no flowers and the leaves have turned slightly yellow. There is also a cutting sometimes made between April and July, but this is only for young plants about six months old which are not cut again later in the same year.

The tedious operation of harvesting the strong woody geranium plants by hand-cutting with a kind of sickle in the severe heat of the Algerian summer is mostly carried out by native labour. For this work, native boys are paid about 5 francs and adults about 10 francs a day. Skilled native field workers earn about 15 to 20 francs a day and native distillers 25 francs, about double these amounts being paid to white labourers. The cost of cutting one hectare (2·471 acres) is estimated at about 400 francs.

The plants, after being harvested, are loaded on trucks and transported to local stills belonging to the farmers who own the fields. Before distillation the plants are allowed to dry for twenty-four hours. It is thought that during this period of drying some fermentation takes place which leads to an increase in the yield of oil.[1]

The distillation is carried out with steam generated in a separate boiler. The stills have usually a capacity of 550 to 650 litres, and are constructed in batteries of three, one battery being generally considered necessary for 10 hectares of geranium plants. These batteries are mostly arranged so as to have only one condenser for each battery. Thus one still only is working at a time, while the other two stills are being discharged and charged respectively. Before commencing the distillation, 20 to 25 litres of water are added to the material in the still.

The duration of each distillation is from about 20 to 45 minutes, depending on the oil content of the plants. The operation is carried out night and day. The average

[1] It may be pointed out that this is not in agreement with Professor A. Rolet's work on *Les Plantes à Parfum et les Plantes Aromatiques*, where it is stated that harvested geranium plants are taken to the distillery as soon as possible, and not allowed to accumulate; for leaves which have fermented are not appreciated by the distillers.

yield of oil from the spring cutting is about 0·1 per cent., and about 0·125 per cent. is obtained from the plants gathered in the autumn. The quantity of oil secured per hectare varies with the weather conditions, the type of soil and the age of the plantation. The following figures are quoted as average yields of oil per hectare: first year, 10 kilos.; second and third years, 30 to 35 kilos.; fourth year, 25 to 28 kilos.; fifth year, 20 to 25 kilos.; sixth year, 15 to 20 kilos.; seventh year, 6 to 10 kilos. These yields include the spring and autumn cuttings, the latter always giving less oil owing to the dry conditions prevailing during the latter part of the year. The producer can depend upon receiving from 180 to 200 francs per kilo. for his oil. To this price must afterwards be added the profits for the exporter, the cost of shipping, and the profits of the importer abroad. The average costs of producing geranium oil in Algeria are as follows: preparation of the soil, ploughing 40 to 50 centimetres deep, 500 francs per hectare; planting about 50,000 plants per hectare, 2,500 francs; working of the ground (to be done every year), 300 francs per hectare; cutting and distilling, including everything such as fuel and labour, 45 francs per kilo. of oil distilled; distillation plant costing 40,000 francs to be written off in six years, 6,700 francs. It costs from 1,000 to 2,000 francs per year for labour and manures to keep up one hectare of geranium. It is stated that during the past few years there have been about 150 growers and distillers of geranium oil in Algeria. Accurate figures giving the total production of oil are not available, for, owing to possible adulteration, export figures are not reliable. An average annual production of about 120 tons during 1926 to 1928 is mentioned as a rough approximation. In 1930 and 1931 the amounts produced were 30 tons and 25 tons respectively. The area under cultivation decreased from 5,000 hectares in 1926–28, to 2,000 hectares in 1931. It appears that old geranium plantations are being replaced by vineyards, which at the present time are more profitable to the farmer.

The odour of freshly distilled geranium oil is described as being generally rough and harsh, and it is mentioned that this objectionable feature is lost after two or three

months' storage in tanks. Oils from the higher altitudes would appear to have a somewhat finer perfume.

(2) *Experimental Cultivation of Geranium in the United States*

The Division of Drug and Related Plants of the Bureau of Plant Industry, United States Department of Agriculture, has for many years been experimenting on the culture of aromatic plants, including some that yield oils used in perfumery. In 1923 the Association of American Manufacturers of Toilet Articles took active measures to promote and encourage such investigations by the Department through their Committee on Raw Products, and made available to the Department a special fund to be used towards the costs of investigating the possibilities of production of several important perfume plants in the United States. A report has now been published by A. F. Sievers, M. S. Lowman and C. G. Marshall, of the Bureau of Plant Industry, on the results of investigations on geranium (*Pelargonium odoratissimum*) (*American Perfumer and Essential Oil Review*, 1932, **26**, 609, 683 ; **27**, 28).

Reference is first made in this report to experiments on *P. odoratissimum* in Florida which were recorded by G. A. Russell in 1921 (*J. Amer. Pharm. Assoc.*, 1921, **10**, 19–26) and led to the following conclusions. Geranium plants can be successfully propagated from cuttings set directly in the field in sandy soil in mid-winter after a fall of rain. Many of the small plants are killed by frost, whilst older plants will freeze to the ground but will subsequently make new growth. The plants will survive much drought and wet weather, but require rapid and thorough drainage. Frequent cultivation is necessary as the plants cannot thrive in competition with weeds. Manures, especially those with high nitrogen content, greatly stimulate growth but have no noticeable effect on the percentage yield of oil. Harvesting by hand is slow and expensive, and suitable machinery should therefore be employed. Distillation with steam presents no special problem, and no loss of oil was noted when the herb was dried before being distilled.

The highest yield of oil, namely 0·109 per cent., was

obtained from leafy herb harvested early in September after dry weather. The lowest yield, namely 0·035 per cent., was obtained from woody material after a rainy period in late August. The highest yield of herb per acre was 16,720 lb. from which 9·33 lb. of oil was distilled. The lowest yield of 1·95 lb. of oil per acre was obtained from 2,435 lb. of herb. The possibility of securing a larger total quantity of oil by harvesting the crop twice a year is suggested. It was considered that the yield of oil under the conditions of this experiment was not sufficient to render the cultivation of geranium profitable.

The two-acre experimental field of geranium from which these results were obtained was abandoned in the winter of 1919. In 1924, when the co-operative agreement with the Association above referred to was made, a sufficient number of plants remained in the abandoned field to furnish 5,000 cuttings. From these, fresh plantings were made, but through want of proper attention and lack of water sufficient material was not available for distillation till October 1929. The plants then harvested were derived partly from the original stock and partly from fresh cuttings obtained from Washington. The plants had been set 2 ft. apart in rows 3 ft. apart. The cutting furnished 9,865 lb. of herb per acre. This furnished 7·7 lb. of oil, or a yield of 0·078 per cent. In June 1930 a second crop, amounting to 6,151 lb. per acre, was cut, which gave 6·1 lb. of oil, or 0.10 per cent. By November the plants had again reached a stage favourable for cutting, but before this could be effected severe cold destroyed most of the growth. The results of this experiment indicate that, given favourable weather, two crops could be obtained per annum, but that if the plants are injured by frost the amount obtainable in June will be greatly reduced. It was considered probable that the yield could be increased by fully 25 per cent. by closer spacing of the plants, and this would have the further advantage of conserving moisture and inducing bushy growth rather than the development of long woody stems.

Experiments in the cultivation of geranium have been made in Southern Texas, but these were relinquished in 1930 owing to the plants being badly damaged by frosts.

The cultivation of geranium in California has received much attention in recent years. Those localities which are best adapted for the plant are, however, also suitable for other crops, particularly certain tropical fruits, and such land therefore is usually too valuable for geranium. The first plantings, which were made in February 1924, did not meet with much success. These were made at National City, San José, Los Gatos and Calipatria. The plants made best progress at San José and Los Gatos. Those at the latter place had attained a height of from 2 to 3 ft. by November, and were in excellent condition for distillation. The plants were, however, retained for propagating purposes with a view to extending the planting, but before this could be done they were badly damaged or killed by frost in December.

In March 1925 a further number of rooted cuttings were shipped from Washington to the United States San Diego Acclimatisation Garden at Torrey Pines. In this locality extremes of temperature are rare either in summer or winter, and although on one occasion 27° F. was recorded, the plants have never suffered any serious damage from low temperature during the six years that the experiments have been conducted. The rainfall averages about 9·6 in., and occurs during autumn, winter and spring. The winter rain was found to be of relatively small importance to the geraniums, for at this period little or no growth takes place. The plants set out in March soon became established, with only a small loss in spite of the fact that their transport occupied seven days. The plot was duly irrigated and cultivated, and by August the plants were in full bloom. Later observations indicated that after the first year the blooming takes place in spring and early summer with only scattered flowers later in the season. Arrangements could not be made to distil the crop until October, when the plants had become very woody and many of the lower leaves had dropped off and others had turned yellow. The amount of herb cut was at the rate of 24,200 lb. per acre, but the yield of oil was only 0·037 per cent. The heavy growth made by the plants during the first year without the application of any manure indicated that the soil contained all the necessary food constituents.

In March 1926 ammonium sulphate was applied at the rate of 400 lb. per acre, and the crop harvested in July amounted to 27,830 lb. per acre compared with 12,906 lb. on the unmanured control plot. In November of the same year the manured plot provided 22,136 lb. of the fresh herb against 10,003 lb. obtained from the control plot; the rate of decline was therefore greater in the manured plot. By April 1927 the yields were reduced to 8,131 lb. and 4,646 lb. respectively. In these experiments, with a view to eliminating the effect of varying soil conditions in the entire area, the ammonium sulphate when first used was applied to four-row blocks with similar blocks between them as controls. The above data are the composite results of the several manured and unmanured blocks. The distillation of these crops could not be arranged. Early in July water was applied to half the area of both the manured and the unmanured block in order to ascertain the effect of irrigation. Three weeks later the crop was harvested, and the yields of herb and oil are shown in the following table:

Influence of Irrigation on the Effect of Ammonium Sulphate Applied at the Rate of 400 lb. per Acre

	Plot I Un-irrigated and unmanured	Plot II Irrigated but un-manured	Plot III Un-irrigated but manured	Plot IV Irrigated and manured.
Yield of herb per acre in pounds (calculated) .	6,869	9,104	8,834	11,284
Yield of oil per acre in pounds (calculated)	4·66	6·67	6·67	9·20
Percentage yield of oil . .	0·068	0·073	0·076	0·081

It will be observed that the effect of irrigation was greater than the residual effect of the ammonium sulphate, but the combined effect amounted to an increase of 64 per cent. in the amount of herb, and an increase of 97 per cent. in the amount of oil produced per acre. No further water was applied in 1927 and the plants received no special treatment until they were again cut in January 1928. The yields of herb from the unmanured plots I and II were at the rate of 5,590 lb. and 6,026 lb. of herb per acre respectively, whereas plots III and IV, manured in 1926, yielded at the rate of 5,445 lb. and 5,808 lb. respectively. These results showed that the effect of the manure had

disappeared, and further experiments were made in February 1928 to determine the effect of ammonium sulphate applied to different plots, at the rate of 2,000, 1,500, 1,000 and 500 lb. per acre respectively, with control plots of similar area between them. Water was also applied immediately, and in April the plants were irrigated again. Two cuttings were subsequently made, the first in May, when the plants were in full bloom, and the second in November, when the crop was much coarser, less leafy and past the best time for distillation. The data obtained indicate that the best results were obtained with ammonium sulphate at the rate of 1,000 lb. to the acre, but it was thought probable that a somewhat smaller quantity would be sufficient. The amount of herb obtained in the May cutting from the plot manured at the rate of 1,000 lb. per acre amounted to 10,132 lb. per acre, yielding 0·106 per cent. of oil, representing 10·74 lb. per acre. This compares with 7,224 lb. from the adjacent control plot, yielding 0·105 per cent. of oil, equivalent to 7·59 lb. per acre. The corresponding figures for the November cutting were 15,667 lb., yielding 0·035 per cent. of oil, or 5·48 lb. per acre, against 9,343 lb. from the adjacent control plot, yielding 0·05 per cent. of oil, or 4·67 lb. per acre. Considered economically it is desirable to harvest the plants at the time they furnish the highest yield of oil. For instance 10,000 lb. of the herb per acre containing 0·1 per cent. of oil will yield 10 lb. of oil, but should it contain only 0·07 per cent. of oil, more than 14,000 lb. of it would be required to produce the same amount of oil per acre, which represents an increase of 40 per cent. in the amount of material that must be handled. This would add very considerably to the cost of harvesting and distilling. After the November cutting, the entire plot received little attention, but there was sufficient winter rain to develop a good growth, and early in June 1929 another cutting was made. This material, which was from the whole plot, amounted to 13,092 lb. per acre. The yield of oil was 0·065 per cent., equivalent to a yield of 8·5 lb. per acre. The plants had been in full bloom for about three weeks and should have been cut several weeks earlier. An application of ammonium sulphate at the rate of 400 lb. per acre, accom-

panied by some irrigation, forced a rapid new growth so that a cutting which was made about the middle of September, equivalent to 13,928 lb. per acre, was a little greater than that obtained in June. The yield of oil was 0.865 per cent., equivalent to 12 lb. per acre. Although the production of oil per acre in three and a half months was 41 per cent. greater than the amount produced in the preceding six and a half months, it should not be concluded that the normal growth of the plants is invariably much greater during the summer period than during the spring months. The plant generally makes the heaviest and bushiest growth in the spring and early summer. The yields depended largely on the manure and water supplied, and must be regarded as peculiar to the cultural conditions described. Without further application of manure the plants produced a crop in May 1930 equivalent to 10,740 lb. per acre, which, however, yielded only 0·048 per cent. of oil, or at the rate of 5·16 lb. per acre. The plants were six weeks past the full blooming period and had become somewhat coarse, although only 10 to 14 in. in height. Ammonium sulphate at the rate of 400 lb. per acre was again applied early in June and the plot irrigated every few weeks. By the end of August the plot yielded at the rate of 12,927 lb. of herb, and 8·53 lb. of oil per acre, equivalent to a percentage yield of oil of 0·066. After a spring cutting in 1931 ammonium sulphate was again applied at the rate of 500 lb. per acre. By midsummer the plants were making uniform growth and appeared to be entirely normal after seven years of continuous cultivation.

In 1930 arrangements had been made to carry out more extensive experiments with geranium on a large ranch near Tustin, California, where plots in four localities were selected, each representing different soil conditions, and cuttings were obtained from Torrey Pines. The planting experiments indicated that previous rooting of the cuttings is unnecessary if they are to be planted in fields which can be irrigated ; considerable saving in the cost of propagation may thus be effected. Late in July 1930 the four plots were harvested and a portion of each distilled. The yields of herb and oil are shown in the following table :

Plot.	Type of Soil.	Yield of Herb per acre (calculated).	Yield of Oil per acre (calculated).	Yield of Oil.
		Pounds.	*Pounds.*	*Per cent.*
1.	Dark, medium to heavy loam	6,260	5·01	0·080
2.	Loam soil covered with blow sand	9,280	7·15	0·077
3.	Loam soil like Plot 2, but with less blow sand	6,180	3·89	0·063
4.	Heavy yellow clay, close grain, becoming hard when dry	2,440	1·76	0·072

It will be noted that Plot 2 gave the largest yield of herb and oil although the percentage yield of oil obtained was slightly less than that from Plot 1. The low yield of herb in Plot 4 was partly due to the fact that the majority of the plants were set later to replace others which had not survived the dry winds occurring immediately after the planting. The yield in Plot 3 was similarly affected, though to a less extent. The effect of the heavy soil in Plot 4 is more evident in the results obtained from the second cutting made in May 1931 which are shown below. As the winter rains had been unusually scanty one-half of Plots 1 and 2 were irrigated to ascertain whether the crop could be increased by such procedure if the rainfall were deficient in the winter months. When cut the plants were larger with hard woody stems and had bloomed heavily four or five weeks previously, but had made considerable new growth shortly before cutting, following late spring rains.

Plot.		Yield of Herb per acre (calculated).	Yield of Oil per acre (calculated).	Yield of Oil.
		Pounds.	*Pounds.*	*Per cent.*
1.	Irrigated	31,200	17·78	0·057
	Not irrigated	24,800	13·89	0·056
2.	Irrigated	22,880	9·61	0·042
	Not irrigated	21,000	15·12	0·072
3.	Irrigated	[1]	[1]	0·051
	Not irrigated	[1]	[1]	0·081
4.	Irrigated	4,700	2·45	0·052

[1] *The plants from this plot were partly cut early in the spring for propagating stock, and no records other than percentage of oil could be obtained.*

The yields of herb and oil show clearly that the heavy clay soil in Plot 4 is less suitable for geranium than the more friable loamy soils. Plots 1 and 2 afforded large yields of herb, indicating satisfactory yields of oil per acre,

although the percentage yield was lower than at the previous distillation. In all the Californian investigations the geranium was harvested by hand, a variety of implements being employed, but it was realised that the successful growing of geranium for profit on a large scale would necessitate the use of harvesting machinery. The usual hay-making machinery was found to be unsuitable as the plants are easily pulled out by a dragging sickle bar or rake, and it is intended to experiment with a special modification of the ordinary hay mower.

In summarising the results of the experiments so far conducted in the cultivation of geranium in the United States, the report states that this crop cannot be successfully grown in regions where freezing temperatures occur even occasionally, and that irrigation is necessary in summer, and sometimes in winter, in districts where the rainfall is rather limited and not properly distributed. Geranium can be easily propagated by slips which under favourable conditions may be planted directly in the field without previous rooting, and the plants, if properly cared for, can be maintained in good productive condition for at least five or six years. Under irrigation in the southern coastal district in California, three crops may be obtained annually if manure and water are used to the best advantage. If the bushy, leafy character of the plants is maintained by frequent cutting, the use of a nitrogenous manure should very materially increase the yield of oil from a unit area by stimulating growth, although such manure apparently does not markedly affect the percentage yield of oil. The quantity of oil obtained from the plant depends on the proportion of leaf surface. Heavy, woody stems contain practically no oil, and their presence therefore merely adds to the cost of harvesting and distilling. Percentage yields ranging from 0·03 to 0·10 have been obtained in California and Florida. It is estimated that with proper use of water and manure an annual yield of oil amounting to about 25 lb. per acre could be obtained in California. The highest yield produced in the experiments was 17 lb. per acre, which was from a single cutting. The experiments have indicated that geranium will not give large returns in America, and that the crop can probably be best grown on

large areas on which labour-saving devices can be used to advantage. The oils produced during the experiments were of excellent quality.

PRODUCER GAS AS FUEL FOR MOTOR VEHICLES

THE publication of articles describing tests carried out with charcoals from British Guiana and Kenya (BULLETIN OF THE IMPERIAL INSTITUTE, 1930, **28**, 139, and 1931, **29**, 437) aroused interest in the possibility of using this fuel in portable producers for road transport vehicles and for other purposes in several countries overseas.

It is thought, therefore, that a brief description of the conditions necessary for the successful application of this form of power production to road vehicles, the relative advantages of wood and charcoal as fuel and some methods of charcoal manufacture, may be of interest.

Producer Gas as a Substitute for Petrol

The use of motor vehicles in districts remote from industrial centres is difficult and expensive if the petrol and similar volatile fuels used have to be imported. The price of liquid motor fuel is necessarily high, even near the coast, and inland the cost rapidly increases on account of freight charges. There is also the possibility that supplies may be cut off in times of crisis, or reduced owing to increased demand in the producing countries. When using petrol in the tropics, the question of loss by evaporation and pilferage has also to be considered, and special conditions of storage are necessary in order to minimise fire risks.

In view of the above considerations, a local substitute for imported petrol for internal combustion engines is very desirable, and it has been demonstrated that this substitute can be found, to a certain extent, in producer gas made in a small producer specially designed and adapted for attachment to a motor vehicle.

The operating principle of this portable producer is exactly the same as that of a large-scale stationary plant in which a mixture of air and steam is passed through a layer of incandescent solid carbonaceous fuel, so that

chemical reactions take place, resulting in the formation of carbon monoxide and hydrogen, both of which are combustible gases of high calorific value and form explosive mixtures with air. The carbonaceous fuels which are used or have been proposed for the purpose include anthracite, coke, wood, charcoal (either ordinary or compressed), carbonised peat and lignite ; but of these, the fuels which are both most suitable and most readily obtainable are wood and charcoal. The relative merits of these fuels are discussed later.

Gas Producers for Motor Vehicles

A number of different portable gas producers for this particular purpose have been designed and patented. These plants differ in construction and detail, but are similar in some essential features. The apparatus comprises two main units, namely, an actual gas producer and a scrubber or cleanser for the gas. The producer consists of a generator in which the gas is made, together with a hopper containing the solid fuel. The generator, which is really a small slow-combustion stove or furnace, is usually provided with a refractory lining and has a grate, the firebars of which are sometimes fixed, but may be of the rocking type with the object of preventing the formation of clinker. Rocking grates, however, take power from the engine and are not easily fitted to standard makes of lorries and tractors. The generator is also fitted with a small water tank and drip-feed by means of which water can be fed continuously, in small quantities, into a vaporiser for the production of steam. In some plants there is also a fan or hand blower for starting up the fire.

Some producers have special features such as arrangements for preheating the air, before it enters the generator, by bringing it into close proximity to the gas which is emerging, at the same time cooling the latter. The scrubber or cleanser, which also serves to cool the gas, is the apparatus in which the gas made in the generator is freed from dust and tarry or other matter likely to cause trouble in the engine. The action of the scrubber is mechanical, the gas being led through a box containing either a series of baffle plates, or wood-wool or similar

material, and eventually passing through a small filter for removing the last traces of dust or tar. Efficient cleansing of the gas is most important, as any dust or other foreign matter reaching the engine will adversely affect its performance. Modern scrubbing arrangements for removing impurities from producer gas are, however, so efficient that there is little if any more wear on the engine with this fuel than with petrol. The relative positions of the various parts of the producer plant on the vehicle will, of course, vary with the type of plant and vehicle.

The method of working is briefly as follows: Fire is lighted in the generator and increased by operating the blower and adding more fuel until combustion is well maintained. The fuel hopper is filled, the water feed regulated, and the blowing continued until gas issues from the valve, when the engine can be started. Starting the engine on gas usually takes about ten minutes from the time that the fire is lighted, but time can be saved by starting it on petrol and then changing over to producer gas as soon as the latter is available. The producer gas supply to the engine is regulated by means of a gas throttle in place of or in addition to the usual petrol throttle.

On changing over from petrol to producer gas with an ordinary motor-car engine a loss of power, sometimes amounting to 30 to 40 per cent. of the rated efficiency, may occur, but this loss can be obviated, to a large extent, by modifying the combustion chamber so as to obtain the higher compression which is necessary with producer gas. A patented high-compression cylinder head of special design to replace the standard type on certain engines is supplied for this purpose by some manufacturers of producer-gas plant, and it is claimed that an engine fitted with this cylinder head is practically equal in its performance to one driven by petrol.

Comparison of Petrol and Producer Gas as Motor Fuel

In comparing the relative merits of petrol and producer gas as fuels for motor vehicles, a number of points need consideration. Where wood or charcoal is used the actual cost of fuel is greatly in their favour, especially in many tropical countries where petrol is expensive while wood

is abundant and cheap. With a producer-gas-driven vehicle, however, allowance must be made for the additional original cost of the producer plant. The maintenance costs are also said to be a little higher than those of a petrol-driven vehicle and the depreciation of the producer plant must, of course, be taken into account in addition to that of the vehicle.

Although the manipulation and driving of a producer-gas lorry is said to be no more difficult than that of a petrol-driven vehicle, the scrubber and filter of the producer plant have to be cleaned out at regular intervals (usually once daily) and the generator also requires cleaning, but less frequently, in order to remove any foreign mineral matter which may have been introduced with the fuel. Where this additional work has to be done by the driver, it may be necessary to pay an increased rate of wages. Consideration would also have to be given to the possibility of prejudice on the part of the driver, especially in the case of a relatively unskilled native, if it were desired to change over from petrol to producer gas.

The time required to start the generator when using producer-gas alone would only be a drawback to the use of producer-gas vehicles on short runs; it is, however, considerably less than that required for steam-driven lorries and in this respect producer-gas plants have an advantage. Starting or re-starting after stops is not as easy with producer gas as with petrol, and it appears to be generally accepted that the flexibility of the engine is rather lower. The average speed which can be maintained is about the same for producer-gas- and petrol-driven vehicles in flat country, but is usually rather lower with the former in hilly country.

The useful load of a lorry is reduced by the weight of the special equipment and of the excess weight of the fuel, over that of the corresponding amount of petrol, which has to be carried. The producer-gas plant weighs, on the average, from 2½ to 4 cwt., depending on its capacity and on the size of the vehicle for which it is adapted. The solid fuel required (wood or charcoal) is also both heavier and much more bulky than the amount of petrol necessary for the same journey, and consequently the radius of

action of the producer lorry is less (usually by about 10 per cent.) than that of a petrol lorry of the same nominal capacity.

It appears therefore that producer gas is likely to find its most useful applications for heavy transport work where frequent stops are not required, such as for agricultural tractors, portable compressors or small marine craft, or for lorries making long journeys, and in countries where the relative costs of fuel are largely in favour of wood or charcoal.

The descriptions given in this BULLETIN (1930, **28**, 139, and 1931, **29**, 437) of the results of tests carried out in London on charcoal from British Guiana and Kenya, include a number of figures showing the relative consumption of charcoal and petrol when used for motor haulage purposes under the same conditions ; but it may be useful to repeat here the figures relating to " Mora " charcoal from British Guiana.

	Charcoal fuel.	Petrol fuel.
Lorry and load wt.	2 tons 4¾ cwt.	2 tons 4¾ cwt.
Distance covered	18·1 miles.	18·1 miles.
Time taken	45 min. 2 sec.	43 min.
Average speed	24·1 m.p.h.	25·2 m.p.h.
Charcoal used	16 lb. 15 oz.	—
Petrol used	—	1·375 gal.
Ton miles per lb. charcoal	2·389	—
Ton miles per gal. petrol	—	29·438

From the above results the following table of relative fuel costs has been compiled :

Fuel.	Assumed cost.	Quantity required.	Cost per 100 miles. s.	d.
Mora charcoal	£2 per ton	93·6 lb.	1	8
,, ,,	£4 ,,	93·6 ,,	3	4
Petrol	1s. 3d per gal.	7·6 gal.	9	6
,,	2s. 0d. ,,	7·6 ,,	15	2

Solid Fuel for Producers ; Relative Merits of Wood and Charcoal

With any solid fuel for a gas producer, a certain degree of uniformity in size is desirable, in order that the feed from fuel hopper to generator may be regular and that an even distribution of fuel in the fire bed may be

maintained. This is necessary in order to prevent the formation of channels through which the incoming air might pass without undergoing any reaction with the incandescent carbon, and thus cause premature combustion of some of the gas, with consequent reduction in the calorific value of that delivered to the engine.

Of the solid fuels which have been used or proposed for use with portable gas producers, anthracite and coke may be regarded as unsuitable. Not only are they expensive and not universally available, but they are also apt to give rise to trouble in the producer. Their content of ash and of sulphur is sometimes high, so that there would be danger of clinker forming on the firebars, while the presence of sulphur compounds in the gas would be very liable to cause corrosion in the producer plant and the engine. The removal of these corrosive compounds would entail very elaborate cleansing arrangements for the gas, and would probably increase the weight of the plant beyond the practical limit.

Quite recently a plant has been designed to use coke produced by low-temperature carbonisation in which it is claimed that clinkering troubles are overcome by means of a special device. The coke is supplied under a guarantee as to its content of ash, volatile matter and moisture, and it is said that trials have proved satisfactory.

The most important of the other solid fuels available are wood, charcoal as ordinarily made, and compressed charcoal. Each of these has certain advantages and drawbacks.

Wood. -Raw wood is obviously the simplest fuel to obtain. It is clean and easily handled and can be used with success in certain types of gas producers. It has the advantage of not being easily crushed in transit so that there is no formation of dust which, if present in large quantities, must be removed before the fuel enters the producer. Hardwood, thoroughly air-dried and preferably free from bark, is generally preferred. This contains as a rule about 20 to 25 per cent. of moisture. For the reason given above, the wood must be cut up into small blocks, preferably about 2 × 2 × 3 cm. and this procedure necessarily involves a considerable amount of labour.

When wood is heated in the generator, it undergoes partial distillation with the evolution of tarry and acid products, which must be removed from the gas before it reaches the engine. Producers using raw wood are, therefore, usually of the " down-draught " type, in which these distillation products pass through the heated zone and are thereby converted into gas before leaving the generator. The moisture in the wood must also be vaporised in the generator, causing a loss of heat, which tends to make for cold and irregular working of the producer. This is an undesirable feature, as it affects the uniformity of composition of the gas made and hence the performance of the engine. Wood is both heavy and bulky and its calorific value is low, so that a considerably greater weight and volume of wood, as compared with petrol or charcoal, must be carried.

Charcoal.—This has been used as a fuel for portable gas producers to a much greater extent than has raw wood, over which it possesses certain marked advantages. The process used for the preparation of charcoal ensures the removal of the bulk of the volatile acid and tarry products which form such an undesirable feature in the use of raw wood, and the percentage of ash in the fuel is low. Hardwood charcoal forms the best fuel, but any charcoal of good quality can be used. Good charcoal can be made practically anywhere (largely by the use of unskilled labour), in one of the portable kilns now available, from material which would otherwise be waste, such as small branches and trimmings. The calorific value of charcoal is higher than that of raw wood and its porous character renders ignition easy.

On the other hand, charcoal has some drawbacks. Thus, the yield is only about 25 per cent. by weight of the wood from which it is made, and it is friable, and hence, when handled or in transit, is liable to form dust which must be excluded from the producer. It absorbs moisture readily and its porous character renders it of low density, so that it is necessary to carry a considerable bulk of fuel.

Compressed Charcoal.—In an endeavour to overcome the above-mentioned drawbacks to the use of charcoal, while retaining its good qualities, a compressed charcoal

fuel has been produced in France. The wood is carbonised in a retort, with the recovery of tar, and the charcoal obtained is ground, mixed with a small proportion of the dehydrated tar and pressed into briquettes, about 3 cm. in diameter. This fuel has the advantage of uniformity in composition and in size, so that the rate of feed to the generator and the depth of fire can be kept constant and the gas produced of constant composition. The briquettes are clean to handle, hard and dense and not easily crushed, so that no dust is formed. Their ash content is low, approximating to that of the charcoal from which they are made. The density of the briquettes approaches unity, which reduces the bulk to be carried and there is very little tendency for them to absorb moisture. The calorific value of the briquettes is claimed to be approximately twice that of raw wood.

The special preparation of such a fuel, however, entails the loss of some of the important advantages of charcoal. Wood distillation, with recovery of tar, involves the use of more elaborate apparatus and of skilled supervision, while the manufacture of charcoal in a kiln is very simple. In order to make compressed charcoal it would probably be necessary to erect a stationary plant, whereas a portable kiln for the preparation of charcoal can be used in any convenient locality. The incorporation of tar in the briquettes, moreover, increases the amount of undesirable volatile matter which has to be dealt with in the producer plant and, from this point of view, if much tar is incorporated, the behaviour of these briquettes would be more comparable with that of raw wood than of charcoal. Experiments have, however, been made on recarbonising the briquettes and so overcoming the tar trouble, but this treatment makes the product more expensive.

On the whole, for ease and simplicity both in the preparation of the fuel and in its use in a portable gas producer, hardwood charcoal of good quality appears to be the most suitable fuel.

Preparation of Charcoal

Charcoal can be prepared by several different methods, but the old and primitive process of charring in " meilers "

or heaps is still practised to a considerable extent. In this, the wood, which must be reasonably dry, is built up into a tapering pile with an air space in the centre, the whole being covered over with turf, clay or soil. The burning takes place from above downwards and from the outside towards the centre. The production of a satisfactory charcoal by this method depends, to a considerable extent, on the skill and experience of the charcoal burner in regulating the admission of air. In spite of the primitive character of the method, the charcoal produced, owing to the slowness of the carbonisation, is usually of good quality and the yield is satisfactory.

A method for making charcoal which is widely adopted at the present time consists in the use of relatively small portable kilns. These are usually made of sheet iron, in sections which can be taken apart without much trouble, so that the whole kiln can be moved from place to place. The yield of charcoal from a kiln is about 5 per cent. greater than that from a meiler, and the kiln has the advantage that the charcoal is kept quite free from stones and dirt: an important feature where it is intended for use in a portable gas producer. The kiln, unlike the meiler process, can also be operated successfully by unskilled labour.

A modern process of charcoal manufacture involves the destructive distillation of wood in retorts with recovery of the by-products of distillation—tar, acetic acid, naphtha, etc. The equipment required for the distillation of the wood and for the recovery and separation of the by-products is elaborate and expensive, so that this process can only be carried out on a large scale and where there is a market for the more valuable of the products.

Characteristics of Charcoal

Charcoal is characterised externally by retaining the form and structure of the wood from which it was produced. The shape of the bark, the annual rings on the transverse sections and the fibrous structure of the longitudinal sections of the original wood are all clearly preserved in the finished charcoal, and afford a means of determining the origin of the product.

A charcoal, to be of satisfactory quality, should have

the following properties: a black and glistening appearance with a distinct blue tinge, the production of a metallic note when struck on a hard object, and freedom from taste or smell. When broken transversely, the freshly exposed surface should be capable of being rubbed without soiling the fingers. The charcoal must be capable of easy ignition and must burn quietly without smoke or flame and without emission of sparks. For use in a gas producer it should also be as hard and dense as possible, since the hardness increases its resistance to abrasion and hence lessens the amount of dust formed, while a high density reduces the volume occupied by a given weight.

Soft, broad-leaved and coniferous woods are more easily charred than are hard woods, but charcoal from hard, heavy wood has always a greater density and calorific value than that from soft woods. Branches are more difficult to char than stem wood and the latter than stump wood, whilst moisture in wood retards charring. Branch woods and those in the round usually yield less charcoal than split woods.

Different species of wood should not, as a rule, be carbonised together, as they will vary in density and combustibility, so that one will be overburned before the charring of the other is complete. If different kinds of wood must be carbonised at the same time, they should, if possible, be of nearly related species.

The yield of good, well-burned charcoal should be about 50 to 65 per cent. by volume and 25 per cent. by weight of the wood used. In general, the slower the process of carbonisation, the better the product.

For the production of charcoal which possesses the desirable properties enumerated above, the final temperature, measured in the interior of the kiln, must be at least 375° C., charcoal produced below 300° C. appearing red or having a reddish tinge. Since, however, under certain climatic conditions, such as extreme dryness, even high-grade charcoal may assume a reddish tint, colour is not always a safe criterion of quality.

Conclusions

It is evident that the production of charcoal, especially in portable kilns, offers an outlet, largely by the use of

unskilled labour, for what would otherwise be mainly waste forest products. The charcoal produced may be conveniently and economically employed in the generation of producer gas for motor traction, this form of motive power having a very definite field of usefulness provided that its limitations are recognised and allowances made for them.

Vehicles operated by producer gas are said to be employed to some extent in parts of Australia and Africa, but have found more extensive use in French Colonies and in France. In the United Kingdom conditions are less favourable to the successful development of road transport by this means, but farm tractors and lorries operated by producer gas are marketed by an English firm who have specialised in the application to vehicles of this form of power production.

NOTES

Flax in the Isle of Man.—The following account of flax-growing experiments in the Isle of Man is taken from the Report of Mr. G. Wyllie Howie, the Agricultural Organiser, for the year ended March 31, 1932.

(1) In co-operation with the Linen Industry Research Association, Northern Ireland, a small experiment in the growing of flax was undertaken. A quarter of an acre was sown with seed supplied by the Association. Sowing took place on April 18, and was followed by a manurial dressing at the rate of 3 cwts. of 30 per cent. superphosphates and 2 cwts. of 30 per cent. potash salts per acre. The plots were harvested on August 11, under the supervision of Mr. J. Stirling, a member of the Linen Industry Research Association's Staff. The yield was 14 cwts. 101 lb., and the flax harvested was despatched to the Association's Research Station to be processed. The preliminary report states that the flax was " nicely ripened and of good colour. The yield of straw and seed was very good," and it is considered that it would be " well worth while to repeat the experiment."

(2) Following upon correspondence with the Linen Industry Research Association of Northern Ireland, experimental plots to test the suitability of modern

pedigree strains of flax to insular conditions were sown at the following centres :

Ballagarey, St. Mark's (Mr. W. Radcliffe).
Ballavarry, Andreas (Mr. R. C. Gill).
Knockaloe Experimental Farm.

Cultivation and manurial treatment was uniform at all three centres, and in accordance with the recommendations of the Linen Industry Research Association, viz. 3 cwts. of 30 per cent. superphosphates and 2 cwts. of 30 per cent. potash salts per acre.

The produce was sent to the Association's Research Station at Lambeg, Northern Ireland, to be de-seeded, retted and scutched, and the report submitted by the Flax and Fibre Production Department following the processing is given below :

TABLE I

Yields Calculated on Basis of One Statute Acre

Plot.	Type of Soil.	Crop Dry.	De-seeded Straw.	Seed Firsts.	Seed Seconds.	Chaff.	Tow, Straw, Rubbish, etc.
		tons.	*tons.*	*cwts.*	*lb.*	*cwts.*	*cwts.*
Ballagarey .	Clay Loam	2·7	2·07	4·5	60	2·4	5·9
Ballavarry .	Peaty Loam	2·8	2·1	5·75	96	3·3	3·0
Knockaloe .	Medium Loam	3·0	2·3	5·4	80	2·8	4·6

TABLE II

Fibre per Statute Acre

Plot.	Scutched Fibre.	Rescutched Tow.	Selling Price of Scutched Fibre, June 3, 1932.
	Stones (14 lb.)	*Stones (14 lb.)*	*per ton.*
Ballagarey . .	55·6	8·5	£72
Ballavarry . .	52·1	10·5	£70
Knockaloe . .	58·5	14·2	£60

Notes

(*a*) A good average crop in England is reckoned at 2½ tons per acre, giving 5 cwts. of seed.

(*b*) The average price for Irish fibre this season ranged from £48–£64 per ton. £72 per ton was the top price. Russian fibre has been ranging from £45–£48 (paper) per ton.

(*c*) The average yield of scutched fibre in Ireland from ordinary flax is 30 stones per acre. The highest yield in the 1931 Irish Trials for a pedigree flax was 42 stones per acre. The average yield in the U.S.S.R. is only about 16 stones per acre.

TABLE III

Total Sales and Expenses on Three Plots of ¼ Acre each

	£	s.	d.	£	s.	d.
SALE OF SEED:						
Firsts, for sowing—436 lb. at 35s. per cwt.	6	16	2			
Seconds, for feeding—59 lb. at 12s per cwt.		6	0			
Chaff, for feeding —236 lb. at 1s. per cwt.		2	0			
				7	4	2
SALE OF SCUTCHED FIBRE:						
Ballagarey—194¼ lb. at £72 per ton	6	5	0			
Ballavarry—182½ lb. at £70 per ton	5	14	0			
Knockaloe—204¼ lb at £60 per ton	5	9	8			
Tow—120 lb. at £15 per ton		16	0			
				18	4	8
				£25	8	10

This equals a gross return of £33 18s. 5d. per acre.

	£	s.	d.
RESEARCH ASSOCIATION COSTS:			
Carriage on Crop (*a*) Isle of Man to Belfast	4	18	1
Carriage on Crop (*b*) Belfast to Lambeg		16	0
Labour de-seeding	1	10	0
Labour retting and scutching	6	14	8
Carriage on Fibre—Lambeg to Belfast		5	0
	£14	3	9

Net returns to Isle of Man equal to £12 6s. 9d. per acre.

Notes

(*a*) All the above are actual sales, except the tow, which was taken into stock at valuation as the quantity was too small to sell to a mill.

(*b*) The operating costs shown are the actual costs of labour employed; these are probably higher than they would be in a commercial factory owing to the quantities dealt with being small and so preventing a continuous run. On the other hand, we have omitted power, heat and overhead charges, as we are not in a position in our experimental factory to estimate these exactly.

(*c*) Looking at the Isle of Man side of the finance, the chief item omitted is the cost of seed, which in this case was provided free, whilst on the other hand, with a factory established in the Island, freight would have to be paid only on seed and fibre and not on straw, i.e. about one-quarter of the tonnage.

(*d*) We have recently got out detailed figures of what we consider should be the costs of production of seed and fibre in a factory built and equipped according to our latest ideas. The average yield of seed and fibre from the three Isle of Man crops is such that on our scale we reckon that a factory could afford to pay £6 per ton of crop stacked at the factory and make a reasonable profit. On such terms the

Isle of Man farmer would receive £16 16s. per acre for his crop, against which he would have to put the cost of seed (30s. to 35s.), cultivation, harvesting and haulage to factory. The aim should be a crop similar to the Ballagarey one, but saved without allowing it to become weathered; in that case we think the crop would be worth up to £6 10s. per ton.

(*e*) The experiment, so far as it goes, shows that in the Isle of Man a flax crop of above the average Irish quality and with a very distinctly higher yield of fibre can be successfully grown and harvested.

The following comments on the crop as received at Lambeg have been made by the Linen Industry Research Association.

Ballagarey.- The flax was well handled, was a good crop, but rather discoloured by weathering.

Ballavarry. The crop was badly weathered but was well handled. The straw was firm.

Knockaloe. -Flax nicely ripened and of good colour. Has been well saved but not very well handled. Soft and somewhat twisted. Suggest it has been grown on too highly manured land.

Thanks are due to Messrs. Gill and Radcliffe for having undertaken the experiment.

Phormium in the Isle of Man. -The following is an extract from the Report of the Agricultural Organiser in the Isle of Man for the year ended March 31, 1932.

Following the recommendations of the Committee of Tynwald appointed to consider the rules governing the registration of unemployed men in their report of June 26, 1931, a Memorandum on the possibilities of cultivating *Phormium tenax* for commercial purposes was prepared on behalf of the Board and submitted to Tynwald in the following December. The Memorandum contained a summary of all the information in the hands of the Board relating to the *Phormium tenax* industry in New Zealand, together with the recommendations of the Committee of expert investigators who visited the Island in 1930 on behalf of the Empire Marketing Board, and an estimate of the sum considered necessary to carry out all experiments on a fairly large scale and extending over a period of five years.

Subsequent to the voting by Tynwald of funds to cover the cost of the first year's work, preparation of the land for planting was started on January 18, 1932.

Operations were carried out on the two areas —Ballaugh

Curraghs and Greeba Valley—and continued until March 31. Plants (48,000) were obtained from Cornwall.

The work, though favoured by continuous fine weather, was impeded considerably, particularly in the Ballaugh area, by the difficulty experienced in clearing the land and cleaning the ditches, most of which showed only too plainly the results of years of continuous neglect.

A large quantity of seed was again obtained from the Mooragh Park, Ramsey, through the courtesy of the Ramsey Town Commissioners. The Forestry Board has again undertaken the raising of seedlings, and it is hoped that future planting will be accomplished entirely with Manx-grown stock. Thanks are due to the Superintendent of the Mooragh Park, and to Mr. A. Johnston, of the Forestry Board, for their help and co-operation in collecting the seed and raising the seedlings, respectively.

The Board is indebted also to the owners of land who have so readily granted facilities for the experiment.

Particulars of men employed, etc., are as follows :

Number of weeks worked		11
Average number of men employed per week		
Ballaugh area	12·1	
Greeba area	18·2	
		30·3

Total amount expended on labour	£569	19	2
Plants (48,000) and carriage thereon	127	18	7
Tools and equipment	45	9	5
Other expenses	35	19	2
Total	£779	6	4

All the men employed were taken from the Register of Unemployed.

Sisal Industry in Angola: Government Assistance.—The following translation from the Angola Boletim Oficial, No. 38, of September 17, 1932, has been kindly furnished to the Imperial Institute by the Comptroller-General, Department of Overseas Trade, who had received it from H.M. Acting Consul-General at Loanda.

One of the crops that, in this Colony, has passed most quickly from the experimental to the practical stage of exploitation is sisal. The first attempts at sisal growing in Angola are recent ; but, notwithstanding this, the areas under cultivation are already very considerable, amounting, at the present time, to something like 8,000 hectares. This enterprise has thus shown a noteworthy development,

demonstrating clearly how suitable are the soil and climate of Angola for the crop. Moreover, Angola possesses vast tracts of country in privileged situations suitable for sisal production.

Looking at the case in its financial and economic aspect, this crop ranks with the most important as a factor of internal and external wealth. Beyond the manifold possibilities it offers within the Colony itself from a commercial and industrial point of view, possibilities that, in the course of time, will necessarily be turned to extensive account, it can and should be the means of drawing gold into the Colony to pay for the important exports of which this fibre is capable. Concurrently it will, obviously, help to vitalise the sum total of the currents, or directives, of labour, sources of wealth and ameliorations that the State is bound to develop and foster, though it be at a sacrifice.

In view of the foregoing :

Whereas, then, the growing of sisal is an asset in the material well-being of the Colony, in its important aspects ; and that it is the duty of the State not only to protect existing plantations, but render their enlargement possible and even promote the creation of new undertakings ;

Whereas, owing to a continuous sagging of the market price for sisal fibre, a drop from £40 a ton to £13, the growers of sisal are in the greatest straits to keep their plantations going, which will entail their ruin, unless they cut their losses and abandon them, seeing that the expenses of the cultivation, preparation and transport of the product exceed quotation values ;

Whereas, while such low quotations prevail, this industry, if it is not to be abandoned, and the present plantations lost, must be protected to the greatest possible extent ;

Whereas the necessary protection may be, in an appreciable degree, afforded by the temporary suspension of the payment of duties on the export of sisal and a partial drawback on the importation of the oil fuel consumed by the respective enterprises, by way of premium ;

After consultation with the Directors of Agriculture and Commerce and of Customs ;

The Acting Governor-General of Angola, making use of the Powers vested in him by Article 29 of the "Carta Organica" of September 1, 1928, and Decree No. 20455 of October 31, 1931, and with the previous authorisation of His Excellency the Minister of the Colonies, determines :

Art. 1.—That the export of sisal shall be exempt from duties, in all the fiscal posts of the Colony, as long as the market quotation for first quality sisal is below £18 a ton.

Paragraph 1.—As soon as first quality sisal reaches quotations ranging from £18 to £20, a half of the duties at present fixed in the respective tariff shall be collected on sisal exports.

Paragraph 2.—As soon as first quality fibre is quoted at £20, sisal will again become subject to the total payment of the export duties, that at this date are fixed.

Art. 2.—To the undertakings, whether of individual or collective character, that treat and press their sisal with machines burning oil fuel, there will be returned the difference between 5 per cent. and 40 per cent., corresponding to the import duties paid on the average quantity of oil used, multiplied by the tons (English) of sisal, that each firm can prove it has exported.

Sole paragraph.—This drawback, which shall be granted only as long as first quality sisal does not touch the £20 mark, will be effected by means of vouchers, made out by the fiscal posts, in accordance with the regulations, and may be utilised by their respective holders for the payment of duty due on any other merchandise.

Art. 3.—Firms desiring to avail themselves of the benefit of the drawback dealt with in Art. 2 will have to supply the Customs authorities with the following particulars :

(*a*) Type of motor, or motors, that drive their machines and tools.
(*b*) Its (or their) potential H.P.
(*c*) Oil consumption per H.P. hour.
(*d*) Output per hour of their fibre-extracting machines, combers, presses, pumps, etc.
(*e*) Power absorbed by these in H.P. hours.

Art. 4.—The Direction of the Customs, after consulting with the Office of Industry and Mines, will draw up, for each enterprise, a table of oil-fuel consumption, in relation to the preparation and pressing of each ton (English) of sisal fibre, which, after approval by this Government, will be communicated in a Service Order, by the Direction of Customs to the fiscal posts, for the purposes of the drawback.

Art. 5.—Legislation to the contrary revoked.

The Apple Industry of Tasmania.—Mr. W. G. Freeman's lecture on "The Empire Fruit Industry" (see this BULLETIN, 1932, **30,** 160) has led to the receipt of a letter from Messrs. H. Jones and Co., of Hobart, Tasmania, from which the following extracts have been taken. They are of interest as descriptive of the organisation of the Tas-

manian industry and also because they may be of value to shippers of fruit in other parts of the Empire.

"The information you presented in such concise form regarding the huge fruit trade of Great Britain has been studied carefully by us, and in particular we have been impressed by your lucid demonstration of the way in which fruit production has increased in so many of the different countries of the Empire. This is one of the problems which we are facing in Tasmania. Thirty years ago our exports of apples to Great Britain were approximately 170,000 cases; this year they totalled 3,415,000 bushels of apples and pears—mostly in bushel cases, but including a small proportion in smaller packages.

"You stated that 'the welfare of Jamaica is very largely dependent on bananas.' The same statement could be made with equal force to the importance of the apple trade to Tasmania. It is not our largest industry from a revenue aspect, minerals and wool taking precedence of it; but from the standpoint of an industry which spreads its earnings amongst a wide section of the State's population the apple industry is definitely of the first importance. Orchard employees, timber millers, then in turn graders and packers, river steamers, railways, motor-lorry drivers, carters, and finally waterside workers (wharf labourers) all participate in the money circulated by the earnings of the apple trade.

"In particular, we were most interested to read your remarks anent the improved conditions in the banana industry of Jamaica as the result of the organisation and transport arrangements of the Jamaica Banana Producers' Co-operative Association. You state 'It is essential to have specially equipped ships calling at regular and frequent intervals. Sufficient fruit in exactly the right stage of maturity must be ready for immediate loading. The conditions during transport must be exactly controlled.' The position is practically identical in the case of the apple export trade of Tasmania, which has developed so remarkably during the past thirty years.

"Tasmania is right out of the track of the principal shipping services trading between the Commonwealth of Australia and Great Britain. In fact, there is only one Line whose vessels call here regularly—i.e. the Commonwealth and Dominion Line (the Australasian service of the Cunard Line). This Line maintains approximately a monthly service inward from London. Exports of general cargo are made by these vessels in order to avoid the expense of local or interport freight and transhipping

charges which otherwise would be incurred in shipping via Melbourne or Sydney.

"During the apple exporting season, however, arrangements are made by a Committee comprising three exporting houses (of which ours is the principal) and two growers' co-operative associations, for steamers of twelve or fourteen shipping Lines to call at Tasmanian ports to load agreed quantities of apples; the steamers being guaranteed their freights, fruit or no fruit. This year, in order to make reasonable provision for the large quantity which the size of the crop necessitated should be exported to overseas destinations (there being only a strictly limited market available in Australia for our apples, as all of the larger States of the Commonwealth are producers of apples themselves), the Committee referred to, chartered six steamers to come out from England specially to load Tasmanian apples. These vessels came out in ballast, and, according to the rules of the Conference Lines (i.e. the Lines whose vessels are regularly in the Australian trade), they were not allowed to load any cargo besides the apples, except bulk or low-freight cargo such as wheat, flour or mineral ores. They were definitely excluded from loading any wool or general cargo. For the most part, these chartered ships had the apple freight as their sole earnings. The same thing occurred in 1928 and 1930, but this year the number of the special chartered steamers was higher than in either of those years.

"There was, of course, a considerable element of risk in chartering these vessels to come out specially from England 13,000 miles to Tasmania, for the contracts had necessarily to be entered into some months before the fruit was known definitely to be available for shipment. The climatic conditions might have minimised or destroyed the crop, but fortunately the Tasmanian climate for the most part is very favourable for the production of apples, and in all instances we were enabled to rather more than fulfil our obligations in respect of the quantities supplied to the steamers.

"In Tasmania, there are approximately 3,000 orchardists who ship apples overseas. Each and every one of these exporting growers receives an allotment of space, either 'per steamer' or 'per Line of steamers' according to the quantity for which the grower has applied and booked space in the season's shipping programme. The whole system is worked out on a strictly equitable basis, so that if any of the steamers carry the fruit imperfectly the loss does not fall too heavily on the individual grower; i.e. the *pro rata* allotting of space obviates this, although

necessarily it entails a lot of additional clerical work at the time the space allotments (the shipping programmes giving the quantities each grower is to forward for shipment by each steamer) are issued.

"We should have mentioned that the shipping season for our apples always commences towards the end of February and proceeds with continuous loadings until the end of April, and in most years nowadays there are steamers loading at slightly longer spaced intervals until the early part of June—so it is really a very limited period in which to get the fruit away.

"We thought we—albeit interested parties—might be permitted to tell you that in this small, far-flung part of the British Empire, having a population of only 220,000 all told, there is in existence an organisation for the handling, shipping and distribution of our apples, very much on the lines, we think, of that advocated by you."

Growth of Young Tea-plants.—An important contribution to the study of the nutrition of the tea plant has been published by Dr. Ir. P. M. H. H. Prillwitz, in a paper on the influence of the degree of saturation and the *p*H value of soils on the growth of young tea-plants (*Archief voor de Theecultuur*, No. 2/3, October 1932, pp. 1–122).

A large series of pot-experiments were carried out in the experimental garden of the Tea Experiment Station at Buitenzorg, the soils used being obtained from different tea-estates. The pots were placed in a slightly shaded plot under natural conditions. They were filled with soil mixed with different quantities of powdered lime or sulphur, in order to vary the degree of saturation and the *p*H value, and after three to four weeks the tea seeds were planted. At the end of the experiment, the average height and the weight of leaves and roots were determined for each plant.

The results showed that in no case did the addition of lime have any favourable effect on the growth of the plants, but, on the contrary, the greater the amount of lime which was added the more the growth was decreased. In pots with an alkaline soil the percentage of undeveloped seeds was noticeably greater than in those pots to which no lime had been added; moreover, at later periods many plants died.

On the other hand, the addition of sulphur definitely increased the growth of the young plants, which had a healthy appearance and possessed a well-developed root-system. Mixtures of lime and sulphur were only found to stimulate growth when the proportions were such that the

concentration of the hydrogen-ions in the soil was increased and the degree of saturation diminished. In general, the best results were obtained by adding sulphur so that a *p*H $\pm$ 4 was reached ; in this case the degree of saturation is very low. The author mentions that the conclusion that a *p*H $\pm$ 4 is the physiological optimum for the growth of young tea can only be accepted with some reserve, since Åslander has proved by water-cultures that the influence of the concentration of hydrogen-ions on the development of different crops is greatly dependent on the concentration of the solutions.

Although primarily the favourable effect of sulphur-manuring is due to the increase of the hydrogen-ions and the decrease of the exchangeable bases in the absorption complex, it is pointed out that sulphur-manuring has secondary results, such as changes in the physical and chemical conditions of the soil.

It is also shown that the development of the tea plant is apparently not decreased in soils with a high exchange-acidity (KCl-solution). The author is of opinion that the very poor results which may be given on estates which have soils originally showing a high exchange-acidity must be due to the circumstance that the soils in question are very poor and the physical conditions are unfavourable for tea.

The good results with sulphur-manuring on some soil types depend to a great extent on the degree of intimacy with which the sulphur is mixed with the soil. It is suggested that in practice sulphur can be used not only in nurseries but on new plantations, by mixing the sulphur with the soil when setting out the young plants.

The author points out that it does not follow that mature tea has the same requirements as young plants and hence experiments in the field will be required to determine the influence of the degree of saturation of the soil on the productivity of bearing estates and on the quality of the manufactured tea.

Tea Yellows Disease.—Prillwitz's investigations dealt with above have an important bearing on experiments on the causation and control of the disease known as " Tea Yellows," which have been carried out by H. H. Storey and R. Leach in Nyasaland and at the East African Agricultural Research Station, Amani (*Bulletin No.* 3, *New Series, Department of Agriculture, Nyasaland, July* 1932). The disease has been a source of trouble to Nyasaland tea planters for many years, particularly on the black friable soil of the Mlanje district, and on soils where deterioration in fertility has been allowed to go unchecked. Affected

plants exhibit a gradual deterioration in health. At first the leaves are normal in size but show a mottling of light and dark green to markedly contrasted yellow and green. Next the leaves gradually diminish in size and show the characteristic mottling; the young leaves tend to become uprolled and brittle and their tips and margins scorched. In the third stage the newly formed leaves are very small and chloritic; the internodes of the stem are considerably shortened and most of the older leaves are shed. In the final stage the thin whippy shoots die back and the last signs of life are usually a few minute axillary shoots at the base of the branches. In young plants suffering from the disease, root development is curtailed considerably but no difference has been noted in the development of fibrous roots in old diseased bushes.

Manurial experiments in the field on both young and old diseased bushes showed that a great improvement in health followed treatment with a fertiliser containing sulphur, whether in the form of sulphate (ammonium, potassium, sodium or magnesium) or of ground sulphur. The results, however, did not preclude the possibility that these materials may have had a detrimental effect on some parasitic organism which may have caused the diseased condition. Water-culture experiments were, therefore, carried out with solutions lacking one or other of the essential elements of plant nutrition. In the solution which lacked sulphur, and in this one only, the exact symptoms of yellows disease were produced even down to the scorching of the young leaves.

It was noticed in the course of the investigations that a root fungus, *Rhizoctonia bataticola*, was commonly associated with tea yellows, but it is not considered that it is the primary cause of the disease. It is thought possible that the disease lays the roots of the plant open to invasion by weakly parasitic fungi, such as *R. bataticola*, and that in all probability the fungi play a part in the last stages of the disease which lead to the death of the plant. The real cause of the disease is attributed to the deficiency of sulphur in the plant.

Following on this conclusion, the control measures are obvious, viz. the application of sulphur in some form to the soil. The minimum amounts required per plant in order to obtain satisfactory results are stated to be: 1 oz. ammonium sulphate or potassium sulphate or ¼ oz. ground sulphur for old plants and half these quantities for young or supply plants. Once diseased areas have been brought back to a state of health sulphur need not be applied at these rates. Plants in the last stage of the disease are

unlikely to respond to treatment and should be dug out and replaced by supplies, followed by the treatment recommended.

Comparative Strength of British Columbia Douglas Fir and Red (or Yellow) Deal.—The results of a most valuable investigation into the relative strengths of British Columbia Douglas fir (*Pseudotsuga taxifolia* Brit.) and red or yellow deal (*Pinus sylvestris* L.) from northern Europe, carried out at the Forest Products Research Laboratory, Princes Risborough, are recorded in " Empire Timbers for Structural Design: British Columbia Douglas Fir " (F.P.R.L., Princes Risborough, 1932, price 6*d*.). As stated in the foreword, the general practice adopted in converting Douglas fir in the saw mills of British Columbia produces sawn material which when finished or planed is ¼ inch less than the nominal dimensions of the cross-sections. Users in this country have hesitated to employ these planed sizes in place of full-size cross-sections of the European redwood, and an investigation was therefore undertaken to ascertain the relative strengths of the planed sizes of Douglas fir and the full size Baltic redwood timbers.

Recently, new grades of Douglas fir have been standardised to meet the needs of the market in this country. These grades are to be distinguished by the name " Ukay Merchantable." The material used for the tests comprised Ukay No. 1 Merchantable and red (or yellow) deal of the grade known as unsorted with nothing lower than fourths, which is, in general, the material with which the B.C. grade mentioned will compete. The table on page 492 gives the results of comparative tests of the " scant "-sized Douglas fir and the full-sized Baltic redwood and illustrates how the greater fibre strength of the British Columbia timber affects the maximum loads that may be carried by joists of that wood as compared with the maximum loads possible for similar joists of the European wood. It will be noticed that the dressed sizes of Douglas fir are actually stronger than the full-size red (or yellow) deal.

The report also includes Tables recording the safe loads for joists or rafters of a varying number of cross-sections and supported on different spans. These Tables give the safe loads for each of three different exposures which represent the liability of the timber to absorb moisture from wetting after being placed in position. In some positions the timber remains dry ; in others it may usually be wet ; in others again it may occasionally be wet. Each of the columns of the Tables is divided by a horizontal line separating the quantities corresponding to the various spans

COMPARATIVE STRENGTHS OF BRITISH COLUMBIA DOUGLAS FIR AND BALTIC REDWOOD [1]

Span 14 ft., Third-point loading, Moisture content in both cases, 16·5 per cent.

Species	Actual size	Maximum load	Greater strength Douglas fir based on Baltic redwood	Actual size	Maximum load	Greater strength Douglas fir based on Baltic redwood
	in	lb	Per cent	in	lb	Per cent
B C Douglas fir	1⅝ × 3⅝	1,310	15	2⅝ × 3⅝	2,060	20
Baltic redwood	2 × 4	1,140		3 × 4	1,710	
B C Douglas fir	1⅝ × 4⅝	2,100	18	2⅝ × 4⅝	3,200	23
Baltic redwood	2 × 5	1,780		3 × 5	2,670	—
B C Douglas fir	1⅝ × 5⅝	3,070	20	2⅝ × 5⅝	4,830	25
Baltic redwood	2 × 6	2,560		3 × 6	3,840	
B C Douglas fir	1⅝ × 6⅝	4,230	21	2⅝ × 6⅝	6,660	27
Baltic redwood	2 × 7	3,490		3 × 7	5,230	
B C Douglas fir	1⅝ × 7⅝	5,580	22	2⅝ × 7⅝	8,780	28
Baltic redwood	2 × 8	4,560		3 × 8	6,830	
B C Douglas fir	1⅝ × 8⅝	7,120	24	2⅝ × 8⅝	11,180	29
Baltic redwood	2 × 9	5,760		3 × 9	8,650	

[1] *The B C Douglas fir as tested was of equivalent grade to Ukay No 1 Merchantable, and the Baltic redwood was unsorted, including nothing lower than fourths.*

into two groups; "the spans above this horizontal line in any column are those for which the safe load is dependent upon the allowable maximum shear stress; the spans below the line are those for which the safe load is governed by the allowable maximum fibre stress." Thus the sizes of joists best adapted for plastered ceilings are those above the line or in some instances immediately below; while those for positions where such ceilings are not supported are found below the horizontal lines.

Mineral Statistics.—The 1929–31 edition of the Imperial Institute Annual Statistical Summary (*The Mineral Industry of the British Empire and Foreign Countries*) was published recently by H.M. Stationery Office (price 6*s*., postage 5*d*.), and contains, as usual, the production and trade figures for forty-eight minerals, of which about one-half are metallic.

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Report on Sea Fisheries of England and Wales for the year 1931. Pp. 84, 9½ × 6. (London: H.M. Stationery Office, 1932.) Price 1*s.* 3*d.*

Annual Report on the Fisheries of New South Wales for the year 1931. Pp. 13, 13¼ × 8¼. (Sydney: Government Printer, 1932.)

Report of the United States Commissioner of Fisheries for the fiscal year 1931, with Appendices. Pp. 690, 9 × 5¾. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Appendices include articles on the Alaska fishery and fur-seal industry, fishery industries of the U.S.A. and the propagation and distribution of food fishes.

Advances in the Preservation of Fish by Freezing. By H. F. Taylor. *Indust. Eng. Chem.* (1932, **24**, 679–682).

Crab Canning. *Food Manufacture* (1932, **7**, 306–307; 320).

Forestry

General

Twelfth Annual Report of the Forestry Commissioners for the year ending September 30, 1931. Pp. 43, 9¾ × 6¼. (London: H.M. Stationery Office, 1932.) Price 9*d.*

Programme of Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for the year 1932–33. Pp. 34, 10 × 8. Mimeographed copy.

Report of the Director of Forestry, Canada, for the fiscal year

ended March 31, 1931. Pp. 19, 9¾ × 6¼. (Ottawa: King's Printer, 1932.)

Administration Report of the Conservator of Forests, Ceylon, for 1931. Pp. 27, 9¾ × 6¼. (Colombo: Government Record Office, 1932.) Price 30 cents.

Decennial Report of the Forest Administration in Cyprus for the years 1921–30. By A. H. Unwin. Pp. 48, 9 × 6. (Nicosia: Conservator of Forests, 1932.) Price 2*s*.

Report on Forest Administration, Federated Malay States, for the year 1931. Pp. 115, 9¾ × 6. (Kuala Lumpur: Government Press, 1932.)

Annual Report of the Forest Department, Kenya, for 1931. Pp. 27, 9¾ × 6¼. (Nairobi: Government Printer, 1932.) Price 1*s*.

Administration Report of the Conservator of Forests, Trinidad and Tobago, for the year 1931. *Council Paper No.* 60 *of* 1932. Pp. 23, 13½ × 8½. (Port-of-Spain: Government Printer, 1932.) Price 1*s*. 6*d*.

Recent Practice in the Treatment of Wind-damaged Forests. *Inter. Rev. Agric.* (1932, **23**, 316T–322T).

Dipterocarpaceæ of the Malay Peninsula. By F. W. Foxworthy. *Malayan Forest Record No.* 10. Pp. 279 + 23 plates, 10½ × 7½. (Kuala Lumpur: Director of Forestry, 1932.) Price $3·50 or 8*s*. 6*d*. This monograph deals with the anatomy of the plants, germination and growth, timber and other economic products and gives detailed descriptions of the genera and species.

Utilization of Big-leaf Maple (*Acer macrophyllum*) of the Pacific North-west. By H. M. Johnson. *Circ. No.* 225, *U.S. Dept. Agric.* Pp. 35, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.)

The Pine Bark Beetle (*Hylastes ater*) in New Zealand. By A. F. Clark. *Circ. No.* 33, *New Zealand State Forest Service.* Pp. 20, 9¾ × 6¼. (Wellington: Government Printer, 1932.) Reprinted from the *New Zealand Journal of Science and Technology*, 1932, vol. 14, pp. 1–20.

Control of the Turpentine Borer (*Buprestis apricans*) in the Naval Stores Region. By J. A. Beal. *Circ. No.* 226, *U.S. Dept. Agric.* Pp. 18, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Deals with the life-history, description and control of this pest of turpentine pines.

Two Destructive Defoliators of Lodgepole Pine in the Yellowstone National Park. By H. E. Burke. *Circ. No.* 224, *U.S. Dept. Agric.* Pp. 20, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.)

The Fumigation of Douglas Fir Seed. By D. Kennedy. *Leaflet No.* 8, *New Zealand State Forest Service.* Pp. 4, 10 × 6¼. (Wellington: Government Printing Office, 1932.) Reprinted from *New Zealand Journal of Science and Technology*, 1932, vol. 14, pp. 58–61.

Timbers

Notes on Malayan Timbers. By E. J. Strugnell. *Malayan Forester* (1932, **1**, 194–197; 246–250).

Which are Our Most Useful Timber Trees? By R. C. Marshall. *Proc. Agric. Soc., Trinidad and Tobago* (1932, **32**, 229–235). Notes on the most important timbers of Trinidad and Tobago.

Contribution à l'Étude des Bois de la Guyane Française. By M. Renaud. *Bull. de l'Agen. Gén. des Col.* (1932, **25**, 970–1031; 1120–1177; 1265–1308; 1372–1421). An account of the timbers of French Guiana and their uses.

Études Systématiques des Bois du Katanga. Fasc. VII. Des Emplois de quelques Bois du Katanga en Fonction de leurs Caractér-

istiques Physiques et Mécaniques. By M. G. Delevoy. *Publication du Comité Spécial du Katanga.* Pp. 52, 8¾ × 5¾. (Brussels: J. Lebègue et Cie, 1932.) Describes the uses of various timbers of Belgian Congo.

Properties of Greenheart, *Ocotea Rodioei* Mez. (Syn. *Nectandra Rodioei* Schomb.). *Investigation* 3, *Project* 22, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 23, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1932.) Mimeographed copy.

Properties of Crabwood, *Carapa guianensis* Aubl. from British Guiana. *Investigation* 6, *Project* 22, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 27, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1932.) Mimeographed copy.

Properties of Purpleheart, *Peltogyne* (?) *pubescens* Benth., from British Guiana. *Investigation* 11, *Project* 22, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 19, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1932.) Mimeographed copy.

Report upon the Comparison of Indian-grown Honduras Mahogany with Native Timber of British Honduras. *Investigation No.* 6, *Project* 23, *Forest Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 30, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1932.) Mimeographed copy.

Peruvian Mahogany (*Swietenia macrophylla* King). By L. Williams. *Tropical Woods* (1932, No. 31, 30–37). An account of the tree, the wood and its uses and properties.

The Timber of Home-grown Scots Pine (*Pinus sylvestris* L.). *Bull. No.* 15, *For. Prod. Res., Dept. Sci. Indust. Res.* Pp. 70, 9¾ × 7¼. (London: H.M. Stationery Office, 1931.) Price 5*s*. Gives a description of the timber and deals with its seasoning, mechanical and physical properties, insects and fungi attacking it, and its antiseptic treatment and utilisation.

The Strength and Related Properties of Redwood. By R. F. Luxford and L. J. Markwardt. *Tech. Bull. No.* 305, *U.S. Dept. Agric.* Pp. 48, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 10 cents.

Timber Tests: Seraya (*Shorea curtisii*). Made at the Timber Research Laboratories, Sentul. *Malayan Forester* (1932, **1**, 205–207).

A Survey of the Damage Caused by Insects to Hardwood Timbers in Great Britain. By R. C. Fisher, F. R. Cann and E. A. Parkin. *Bull. No.* 16, *For. Prod. Res., Dept. Sci. Indust. Res.* Pp. 27, 9¾ × 7¼. (London: H.M. Stationery Office, 1932.) Price 2*s*. 6*d*.

Some Minor Stains of Southern Pine and Hardwood Lumber and Logs. By T. C. Scheffer and R. M. Lindgren. *Journ. Agric. Res.* (1932, **45**, 233–237).

The Kiln Drying of East African Timbers. By W. D. Arnot. Pp. 80, 9¾ × 6¼. (Nairobi: Government Printer, 1931.)

The Durability of Fence Posts. By J. C. Wooley. *Bull.* 312, *Missouri Agric. Exper. Sta.* Pp. 8, 9 × 6. (Columbia, Missouri: University College of Agriculture, 1932.)

The Preservative Treatment of Fence Posts, with Particular Reference to Western Australia. By J. E. Cummings. *Journ. Dept. Agric., W. Australia* (1932, **9**, 186–197).

The Chemistry of Australian Timbers. Part 2. The Chemical Composition of the Woods of the Ironbark Group. By W. E. Cohen, A. L. Baldock and A. G. Charles. *Pamphlet No.* 32, *Counc. Sci. Indust. Res., Australia.* Pp. 36, 9½ × 6. (Melbourne: Government Printer, 1932.)

Composition of Philippine Woods. By L. Baens, F. M. Yenko, A. P. West and H. M. Curran. *Philippine Journ. Sci.* (1932, **48**,

299–304). Gives description and analysis of the following: Alupág (*Euphoria cinerea* Radlk.), Banai-banai (*Radermachera pinnata* Seem), Benguet pine (*Pinus insularis* Endl.), Balobo (*Diplodiscus paniculatus* Turcz) and Dulit (*Canarium multipinatum* Llanos).

The Principles of Woodworking. A Survey of Present Knowledge on this Subject. By W. W. Barkas, E. D. van Rest and W. E. Wilson. *Bull. No.* 13, *For. Prod. Res., Dept. Sci. Indust. Res.* Pp. 35, 9¾ × 7¼. (London: H.M. Stationery Office, 1932.) Price 2*s.* 6*d.*

A Wood Chemical Plant Built to Meet the Competition of Synthetic Products. By T. C. Albin. *Chem. and Met. Eng.* (1932, **39,** 382–387). Description and working of a large wood distillation plant in the United States.

Gums and Resins

Didi Resin (*Canarium vitiense*). By W. J. Blackie. *Agric. Journ., Fiji* (1932, **5,** 32–33). Analysis and properties of the resin.

A Report on the State of Lac Cultivation and General Condition of the Lac Industry in Burma. By D. Norris. Pp. 26, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1931.) Price 8 annas.

Comparative Study of Lac Hosts with Special Reference to *Acacia Catechu* and *Cassia florida.* By A. K. Thakur. *Bull. No.* 9, *Indian Lac Res. Inst.* Pp. 8, 9½ × 6¼. (Namkum, Ranchi: Indian Lac Research Institute, 1932.) Price 8 annas.

Humidity and Storage of Button Lac. By R. W. Aldis. *Bull. No.* 5, *Indian Lac Res. Inst.* Pp. 4, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1932.) Price 8 annas.

Orpiment and the Iodine Value of Shellac. By M. Rangaswami and R. W. Aldis. *Bull. No.* 7, *Indian Lac Res. Inst.* Pp. 4, 9¾ × 6¼. (Namkum, Ranchi: Indian Lac Research Institute, 1932.) Price 8 annas.

The Iodine Value of Shellac. By R. W. Aldis. *Bull. No.* 8, *Indian Lac Res. Inst.* Pp. 5, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1932.) Price 8 annas.

Tanning Materials

International Trade in Tanning Materials. *Leather World* (1932, **24,** 824–826).

Consumption of Vegetable Tanning Materials in the United Kingdom. *Leather World* (1932, **24,** 762–764).

Report of Special General Meeting of the Wattle and Timber Growers' Association, held on Thursday, September 8, 1932. Pp. 6, 13½ × 8¼. (Pietermaritzburg: Wattle and Timber Growers' Association, 1932.) A symposium and discussion on the bagworm pest of wattle in South Africa.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

CASTE AND CREDIT IN THE RURAL AREA. A Survey by S. S. Nehru, B.A., B.Sc., M.A., Ph.D., I.C.S. Pp. xvi + 174, $7\frac{1}{2} \times 5$. (London, Calcutta, Bombay, Madras, Toronto and New York: Longmans, Green & Co. Ltd., 1932.) Price 6*s*.

In this BULLETIN (1932, **30**, 95) a notice was published of a small but valuable symposium on *Modern India*, and the present volume might usefully be perused by readers of the former work as offering a specialised treatment of the caste question in a rural area. The author has carried out a social and economic survey of over fifty villages in a typical district of the middle Ganges Valley, and has certainly produced a treatise containing not only a considerable quantity of statistics and other concrete statements, but a readable account, not devoid of humour, of the inter-relation and economic position of the rural castes. The complicated conditions prevailing may be gathered from the fact that no less than fifty-two castes exist in the region in question, and that these are divisible into high, upper, middle and lower castes, in addition to the "untouchables." The author devotes a considerable amount of space to the subject of rural welfare in all its branches, and shows that much is being done to improve the material and moral progress of the community, so far as is possible under what he terms "the appalling conditions prevailing in the rural area." The book is well worth perusal by any serious investigators of Indian conditions who have not yet had occasion to study the subject of caste economics and of rural occupations in relation thereto.

CENSUS OF NIGERIA, 1931: Vol. IV, CENSUS OF LAGOS. By H. N. G. Thompson. Pp. 53, $13\frac{1}{4} \times 8\frac{1}{4}$. Price 6*s*. Vol. V, MEDICAL CENSUS, NORTHERN PROVINCES. By Dr. R. C. Jones. Pp. 92, $13\frac{1}{4} \times 8\frac{1}{4}$. Price 7*s*. (London: The Crown Agents for the Colonies.)

These two volumes of the Census of Nigeria, which are the first to appear, contain much well-arranged and practical information. The Medical Census of the Northern Provinces furnishes some interesting observations on the difficulties attending such a census under West African conditions, and also brief descriptions of the climate and

environment of the villages investigated and of the ceremonies and customs of the inhabitants. The results of the medical census are regarded as in some respects disappointing, but it is pointed out "that the investigation was experimental and no progress can be achieved unless a beginning is made."

TRISTAN DA CUNHA. By Douglas M. Gane. Pp. 173, $7\frac{3}{4} \times 5\frac{1}{4}$. (London: George Allen & Unwin, Ltd., 1932.) Price 7*s.* 6*d.*

The small outpost of the Empire known as Tristan da Cunha possesses features of particular interest, and this book should appeal to a wide circle of readers. It presents the history and present conditions of the Island in an attractive way, and also contains a chapter on the moral and physical condition of the inhabitants which is of value from the standpoints of sociology and medical science. Several illustrations from photographs add to the interest of the book.

COFFEE PLANTING IN KENYA COLONY. By F. H. Sprott. Pp. xxxvii + 104, $9\frac{1}{2} \times 6$. (Nairobi: The East African Standard, Ltd.) Price 10*s.*

For many years Empire coffee growers suffered because of the lack of any sound book, written in English, dealing generally with the cultivation and preparation of the product on which their welfare depends. Information on various phases of the industry was available in numerous scattered bulletins and pamphlets, issued frequently by Agricultural Departments, whilst there were also a few, but very few, more or less comprehensive works which although valuable did not afford the planter practical guidance suited to his particular circumstances.

The British coffee growers in East Africa need no longer suffer under this disadvantage since there are now two books available to them. Attention has already been drawn in this BULLETIN (1930, **28**, 252) to Mr. J. H. McDonald's *Coffee Growing: with Special Reference to East Africa*, and quite recently a copy has been received of the volume under review, in which Mr. F. H. Sprott has revised and brought up to date his own *Practical Coffee Planting*, for some years out of print.

In Part I, Mr. Sprott addresses himself particularly to the prospective planter, and gives useful advice on general conditions in Kenya, the most suitable coffee districts, land tenure, the handling of local labour, the daily routine, estate book-keeping and estimates of expenditure and

contribute to the excellence of the work and facilitate reference to its contents. This volume can be highly recommended and should prove of great practical assistance to public and other analysts, while the reports of proceedings taken should in addition be useful to members of the legal professions.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Revised by W. Harrison Martindale, Ph.D., Ph.Ch., F.C.S. Twentieth Edition. Vol. I. Pp. xlviii + 1216, $6\frac{1}{2} \times 4$. (London: H. K. Lewis and Co., Ltd., 1932.) Price 27*s*. 6*d*.

The new edition of this indispensable reference book, now in its fiftieth year of publication, follows the general lines of its predecessors. Many new remedies and new methods of using old ones are included, whilst the book has been brought up-to-date in many other directions. It is unfortunate, however, that its date of publication should have coincided with that of the new British Pharmacopœia, for this has prevented a complete revision in the light of the changes effected by the latter. The author has overcome the difficulties in this respect to some extent by including the recommendations of the various Reports of Sub-Committees of the Pharmacopœia Commission published by the General Medical Council from time to time during the last two years, whilst a synopsis of the principal additions and changes effected in the new official work is printed in the Introduction.

NATURAL VARNISH RESINS. By T. Hedley Barry. Pp. xii + 294, $10 \times 6\frac{1}{2}$. (London: Ernest Benn, Ltd., 1932.) Price £2 2*s*.

This book is based on the section on Natural Resins which the author contributed to *Natural and Synthetic Resins*, by T. Hedley Barry, R. S. Morrell and Alan A. Drummond, published in 1926. With the exception of a short chapter on the botanical origin of resins by Dr. J. C. Willis, the subject-matter has been thoroughly revised, and considerably extended.

The first section of the book commences with an interesting historical introduction to the subject. This is followed by a general survey of the physical and chemical properties of resins, and a description of the methods used for determining their chemical constants. Although research on natural resins has received considerable attention during recent years, the reader will observe that there is still comparatively little known about the chemistry of

most of the complex constituents of natural resins. At the conclusion of the last chapter of this section, concerned with the decomposition of resins by heat, the author states that " the elimination of gum-running, as practised under present conditions, is absolutely essential if the natural resins are to retain their position as basic materials for varnish-making."

The second part of the book is devoted to the individual resins, and the author contributes valuable first-hand information, which he has received from the Forest Departments of the chief countries concerned. Particulars are given of the methods of collection, tapping and grading of commercial varnish resins, their physical and chemical properties, and trade statistics. Separate chapters deal with East African, West African, South American, East Indian and Manila copals, whilst information is also furnished on Kauri, Damar, Acaroid resin, Sandarac, Mastic, Dragon's Blood, Gum Kino and Natural Lacquers. Considerable space is devoted to turpentine and rosin, and information is given concerning the turpentine industries in all producing countries, the species of pine trees utilised, methods of tapping, solvent extraction processes, and the chemical nature and value of the products. Special attention is given to the chemical constitution of rosin, its derivatives, and industrial applications. The last chapter treats of shellac.

The book contains numerous excellent illustrations, and copious references to original sources of information. It will prove of considerable value to all interested in the subject of natural resins.

LUMBER AND ITS USES. By Royal S. Kellogg. Fourth edition, revised, enlarged and entirely re-set. Pp. xix + 378, $8\frac{3}{4} \times 5\frac{3}{4}$. (New York: Scientific Book Corporation, 1931.) Price 18*s*.

This is an entirely revised and enlarged edition of a work which has long been a standard handbook in the United States for those interested in timber and its industrial applications. The book in no way departs from previous issues in dealing with the subject-matter in non-technical language which, however, is used without any sacrifice of definiteness or accuracy. Apart from general revision the new material included in the present edition is mainly in connection with the chapters dealing with the problems of wood construction and with the recently adopted specifications for American lumber standards (1931). These latter are fully dealt with and cover both softwoods and hardwoods.

The book, although primarily intended for American readers, is of much value to workers and the trade in this country. Chapters on the structure and physical properties of wood are succeeded by a discussion of lumber and log measurements, grades and sizes of lumber, and structural timbers. The seasoning (air and kiln-drying) and preservation of wood are dealt with and the methods of using paints and finishes are discussed. The main section of the book comprises a series of chapters concerned with the use of timber in general construction, planing mill products and the factory use of lumber. These chapters together with the succeeding account of the commercial woods of the United States and their applications constitute a rich source of information presented in readily accessible form. Concluding chapters deal with the present present state of timber supply and lumber operations in the United States, with remarks on wood and its competitors, and the organisations in America (public services and commercial associations) which are in a position to supply all classes of timber users with reliable information as to their needs. The book is well illustrated and most conveniently and practically bound.

British Columbia Softwoods; their Decays and Natural Defects. By H. W. Eades, B.Sc.F., Department of the Interior, Canada; Forest Service Bulletin No. 80. Pp. x + 126. (Ottawa: King's Printer, 1932.)

There is no doubt that this excellent and well-illustrated little hand-book will succeed in its object of "serving as a work of reference or as a text-book for graders and those who wish to learn something about the defects and blemishes and the pathology of wood." It has been compiled as a result of continuous enquiry from the lumber industry of British Columbia for full information as to the appearance and significance of the various stains, rots and other natural defects met with in the softwoods of the Province. It aims at giving the required particulars on these points, and also information as to the blemishes and discolorations, a knowledge of which will enable the grader to apply his grades correctly to lumber presenting these faults.

This aim is achieved in some seven chapters, with useful appendixes, which deal with wood-inhabiting fungi, the recognition of defects caused by stain and decay, the chief wood-rotting fungi of British Columbia, the durability of softwoods and defects caused by insects and marine organisms. The educational value of the book is greatly enhanced by the inclusion of a useful introductory chapter

on the general anatomy and physiology of a tree and also subject-matter based on the information prepared by the Vancouver Forest Products Laboratory in connection with the educational classes organised by the British Columbia Lumber and Shingle Manufacturers, Limited. There is, further, a section describing the species of British Columbia softwoods. The photographs, some of which are coloured, form a valuable feature of a book which is a welcome addition to timber literature.

THE PRINCIPLES OF WOODWORKING. A SURVEY OF PRESENT KNOWLEDGE ON THIS SUBJECT. By W. W. Barkas, M.Sc., E. D. van Rest, B.A., B.Sc., and W. E. Wilson, M.A.S.W.-C.M. Department of Scientific and Industrial Research, Forest Products Research, Bulletin No. 13. Pp. vi + 35, 9½ × 7¼. (London: His Majesty's Stationery Office, 1932.) Price 2*s*. 6*d*.

This publication is essentially an introduction to what promises to be a most valuable piece of technical research proposed by the Forest Products Research Laboratory, namely, an investigation of the working and machining properties of timbers used or likely to be used in this country. In recent years there has been brought on to the market an increasing number of timbers from Empire and other sources. In endeavouring to find an outlet for these relatively unknown materials it is of great importance to have available reliable information as to their working and machining properties, since the cost of labour involved in the processes concerned forms a large part of the cost of production of the finished articles. Intimately connected with this subject is the necessity of a knowledge of the cutting action of the tools employed and of ascertaining the best type of tool to use for different species of timber.

There can be no doubt that information of this kind obtained by practical research carried out on scientific principles would be of great industrial value and form a most valuable complement to the investigations of strength, seasoning and durability which hitherto have received more attention in timber investigations. As a preliminary to such research an enquiry into present knowledge of the underlying principles of woodworking was essential and the Bulletin under notice gives the results of such a survey carried out by the Section of Timber Physics of the Forest Products Research Laboratory. The four principal sections deal, respectively, with the general principles of cutting, the action of rotating cutters (planers, spindle moulders and drills), saws (rip and cross-cut), and sugges-

tions for experimental work. In addition, a series of appendixes discuss technical and mathematical aspects of cutting action, and there is also a bibliography. The publication is well illustrated and forms a most welcome statement of a subject hitherto difficult to follow in scattered literature.

IRRIGATION PRINCIPLES AND PRACTICES. By Orson W. Israelsen, Ph.D. Pp. xiv + 422, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 31*s*.

The scope of this work may best be indicated by quoting a few sentences from the preface by the author, who is Professor of Irrigation and Drainage in the Utah State Agricultural College:

"My main objective in the preparation of this volume has been to meet the needs of college and university students who seek information concerning the aspects of irrigation which are not considered in works on irrigation engineering. These aspects of irrigation, which are sometimes referred to as the agricultural phases, are of special interest to students of agriculture and agricultural engineering. They are also of interest to civil engineering students. Although the needs of students have been given first consideration, and irrigation principles therefore stressed, a considerable amount of material describing modern methods and practices also is included. . . . I have aimed to include also material that will be of value to leaders in irrigation affairs who recognise the basic importance of proper use and control of irrigation water to the perpetuation of profitable agriculture in arid regions."

Starting with the reflection that irrigation is a very ancient art and that in the past, although civilisations have risen on irrigated areas, they have also decayed and disappeared, the author discusses generally the relations of the cultivator and the community to irrigation. The sources and conveyance of irrigation water, modes of measurement and application, including the necessary implements, structures and machinery, are next dealt with, after which detailed consideration is given to soils in their relation to water, including the alkali problem, the lack of understanding of which has frequently led to failure. A consideration of the economical use of water in regard to both time and amount of application, with chapters dealing practically with the irrigation of such specific crops as cereals, alfalfa, sugar beets, potatoes and fruit orchards, form another section. In the two concluding

chapters irrigation in humid climates and some general problems are discussed.

Noteworthy features of the book are the very numerous and excellent illustrations, the extensive bibliographical references and the set of problems and questions on the subject-matter of each chapter.

To avoid misconception it may be well to mention that the examples of irrigation works referred to, and the literature cited, are almost exclusively confined to North America, which has only about one-eighth of the 200 million areas of irrigated land in the world, whilst Asia has nearly three-quarters. Professor Israelsen is, however, dealing with principles, and his clear exposition of these will undoubtedly be of great value to all those workers who, in whatever part of the world, are endeavouring to place irrigation on a more scientific basis than hitherto in the hope of achieving permanently beneficial results.

An Introduction to the Scientific Study of the Soil. By Norman M. Comber, D.Sc., A.R.C.S., F.I.C. Pp. 208, $7\frac{1}{4} \times 4\frac{3}{4}$. Second Edition. (London: Edward Arnold & Co., 1932.) Price 7*s*. 6*d*.

The author of this little book is Professor of Agricultural Chemistry in the University of Leeds and the contents are based upon his courses of lectures to students. The main object of the book is to provide the general agricultural student with a concise account of the science of the soil, so that the reader is assumed to have a certain amount of elementary knowledge of botany and geology, as well as of chemistry and physics. This present edition of the book (the first edition having been published in 1927) has amplified and brought up to date the information included in the previous edition, especially in the important sections dealing with the mechanical analysis of soils, soil microbiology and the classification of soils. In this last section, the various systems of classification and their limitations are indicated and attention is drawn to the importance of recent work by Russian investigators.

An excellent feature, unusual in a book of this character, is a chapter devoted to the literature of soil science, indications and guidance being given as to the use by the student of original papers and abstracts, a matter which the author rightly regards as of the first importance.

Although the amount of space devoted to each item of the subject is necessarily short, the work gives a comprehensive survey of the whole field, dealing with both practical and academic aspects. It should prove useful, not

only to students, but to others desirous of obtaining a general idea of the present position of the science of the soil.

La Géologie et les Mines de la France d'Outre-Mer. Recueil de conférences organisées au Muséum par les soins du Bureau d'Études géologiques et minières coloniales sous le haut patronage de M. A. Lacroix, Secrétaire perpétuel de l'Académie des Sciences, et avec le concours de MM. L. Bertrand, F. Blondel, J. Bourcart, A. Demay, M. Dreyfuss, L. Dubertret, P. Fallot, M. Glasser, H. Hubert, Ch. Jacob, L. Joleaud, A. Lacroix et L. Neltner. Pp. viii + 604, $9\frac{3}{4} \times 6\frac{1}{4}$. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1932.) Price 60 francs.

This welcome volume is the outcome of lectures, by specialists in geological and mining work in the French colonies and protectorates, delivered at a series of conferences held at the Muséum d'Histoire Naturelle de Paris, during 1931–32. The conferences were organised by the Bureau d'Études géologiques et minières coloniales, a body recently formed to give effect to the recommendations of the Comité d'Études minières pour la France d'outre-mer, which is itself sponsored by the French mining and metallurgical industry. The economic importance of geological and mineral surveys is now recognised. It is intended to organise courses of instruction at the schools and universities with the object of training engineers and geologists for work in the Colonies, and to supplement the present volume with a series of publications on the geology and mineral deposits of the French colonies. The general awakening of interest is further signified by the fact that French geologists now participate in the conferences of geological surveys in tropical Africa.

In this book, the colonies are dealt with in geographical order, beginning with Algeria and Tunis, and ending with French Guiana. In each case, an historical account of the development of geological exploration is followed by details of physical geography, stratigraphy and tectonics, with a description of known mineral deposits and prospects. An effort is made to correlate the strata with those of neighbouring territories as far as possible.

Folding geological maps of the larger possessions are given in two colours, together with geographical maps of the smaller units. Among the geological maps are: North Africa (Algeria, Tunis and Morocco) on a scale of 1 : 3,000,000; French Africa (including North, West and

Equatorial Africa and British possessions in the West), on a scale of 1 : 10,000,000; Northern Indo-China (1 : 3,000,000); Madagascar (1 : 6,000,000); and New Caledonia (1 : 1,500,000). In addition there are included in the text numerous tectonic maps and sections.

Up-to-date accounts are given of the better known mineral deposits, such as those of lead, zinc, iron ores and phosphates in Algeria and Tunis, the Indo-China tinfield, New Caledonia chromite and Madagascar graphite. Interesting details are included concerning new prospects and important deposits on which information has not hitherto been readily accessible, such as the French Congo copper ores, and the diamond field of Oubangui-Chari. The latter is compared not with the Transvaal, but with the Somabula (Southern Rhodesia) field. The copper ores are ascribed to mineralisation in post-Kundelungu, pre-Lubilache time, and are compared with the deposits (also associated with dolomites) of Katanga and Otavi.

The closing chapter of fifty-one pages deals with the occurrences and prospects of petroleum in French colonies, but almost half this chapter is devoted to an outline of geological principles in regard to petroleum. The author concludes that no large supplies of petroleum are likely to be obtained from French colonies. Supplies may be forthcoming from France's share in the 'Iraq field, and a description of this field is therefore given.

At the end of the book are tables of mineral statistics for each colony for the years 1928–30. The inclusion of a summary of the contents of each chapter is a useful feature. The description of each colony is followed by a bibliography of works by French authors, and the volume concludes with indexes to geographical names, and to geological and mining terms used. The book should prove of considerable value to all interested in the mineral resources of the French colonies.

A TEXT-BOOK OF MINERALOGY. By Edward Salisbury Dana. Fourth Edition, Revised and Enlarged by William E. Ford. Pp. xi + 851, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 34*s*.

The fourth edition of this well-known text-book is particularly welcome at the present time, coming as it does after a decade of considerably active mineralogical investigation and research. Not only does this edition represent a notable improvement over its predecessors, but it contains a complete, though necessarily brief, statement

of the important facts of all well-defined mineral species recognised by mineralogists up to January 1, 1932. Brief notes are also included regarding both doubtful and discredited mineral species, so that the " Index to Species " contains no less than 3,100 entries.

In addition to the revision, this edition includes important new sections, among which may be mentioned some seventeen pages on crystal structure and investigation by X-ray analysis, and eighteen pages on the origin, mode of occurrence and association of minerals. Details of some 220 new mineral species have also been incorporated in the main body of the text.

Errors, both typographical and otherwise, are not uncommon in a work of this description, but the present edition appears to be practically free from such faults. It has been very carefully compiled, and undoubtedly represents the most up-to-date and complete text-book on mineralogy that has so far been published.

A Key to Mineral Groups, Species and Varieties. By Edward S. Simpson, D.Sc., B.E., F.A.C.I. Pp. viii + 84, 9¾ × 6¼. (London: Chapman & Hall, Ltd., 1932.) Price 10*s.* 6*d.*

This book is essentially a dictionary of mineral species, and forms a rapid and simple means of ascertaining the composition, chief properties of diagnostic value, and best sources of detailed information regarding practically all well-defined minerals. Upward of 2,000 mineral names have been listed, but the author has purposely omitted many names that show signs of dying out of literature, or that merely represent small or insignificant variations of established species.

The mineral names are tabulated in alphabetical order, the more important references, together with the chemical composition, crystallographic system, specific gravity and refractive indices of each mineral being arranged in adjacent columns. It is desirable, however, that the user of this concise index should study carefully the author's introductory remarks, in which it is pointed out, among other things, that diacritical marks have been eliminated from foreign names as being entirely unnecessary in a work of this description. The Swedish " å," moreover, has been transliterated as " o " ; but such a treatment may possibly lead to confusion and the oversight of names in the alphabetical arrangement adopted. The author, however, appears to realise this difficulty, and has been inconsistent in his treatment : thus åkermanite has been

indexed under both akermanite and okermanite, while ånnerödite has been listed as annerodite and not onnerodite. With regard to constitutional formulæ, these have been reduced to their simplest terms and nearly all common isomorphous replacements have been omitted. Published data for specific gravities have been revised and sometimes corrected by references to artificial compounds or by calculation from known gravities of other isomorphous minerals, while for both uniaxial and biaxial minerals, wherever possible the average highest and lowest correlated refractive indices are given so that the average birefringence can be obtained by simple subtraction.

In general, it may be said that this work forms a useful supplement to the standard reference books on mineralogy, and should prove valuable as a list for reference.

THE SCIENTIFIC PRINCIPLES OF PETROLEUM TECHNOLOGY. By Dr. Leo Gurwitsch and Harold Moore, M.Sch. Tech., M.I. Petrol. Tech., F.C.S., A.I.Mech.E. New Edition. Pp. xii + 572, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Chapman & Hall, Ltd., 1932.) Price 30*s*.

This publication is a revision of Moore's English translation of the second edition of the late Professor Gurwitsch's well-known text-book. The present volume shows an increase of about 100 pages over its predecessor, the additional matter dealing chiefly with the technical aspect of the subject.

The first section of the book (175 pp.) deals in a fairly comprehensive manner with the behaviour of the constituents of petroleum towards chemical reagents, and now includes an additional fifteen pages on sulphur.

The matter relating to the physical properties of petroleum, which occupies eighty pages, remains much the same as in the first edition with the addition of data concerning transformer oils. The chapter headed "brief characteristics of the most important petroleum oils" seems to have largely escaped revision and is, in some respects, disappointing. Thus, Mesopotamia ('Iraq) is dismissed in four lines which only give its geographical situation, whilst in the five lines devoted to Trinidad, the Asphalt pitch lake is described as being the most notable crude oil locality in the Island.

In the section on manufacture (180 pp.) the author, after describing briefly the theory of distillation and fractionation, gives a concise account of the processes involved, including pressure distillation, liquid and vapour phase cracking methods and the Bergius process.

The ensuing section of nearly 100 pages gives a good account of the chemical and physical means adopted for the refining of petroleum distillates and of the chemical reactions involved in the numerous processes described.

The concluding section discusses the many products marketed by the petroleum industry, and although it occupies fifty-five pages no reference is made to the use of residual bitumen for road surfacing nor to heavy oils for Diesel engine use.

It is observed that the author has retained the tables showing the results of examination of various illuminating oils published by Engler and Ubbelohde in 1907.

Although certain sections of the book could with advantage be still further revised, the volume contains much of value and can be recommended to all interested in the chemistry of petroleum and its products.

MICROCHEMICAL LABORATORY MANUAL. By Friedrich Emich, Dr. Phil. H. C., Dr. Ing. E. H., with a section on Spot Analysis by Dr. Fritz Feigl. Translated by Frank Schneider, Sc.M. Pp. xvi + 180, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 18*s*. 6*d*.

This book is a welcome translation of Dr. Emich's well-known manual on micro-chemical methods of analysis.

It can be divided into two parts, apparatus and technique being described in the first, and applications to special cases being considered in the second. These applications include the detection of inorganic anions and cations, qualitative organic analysis and preparations, and a few of the most important quantitative inorganic gravimetric and electrolytic methods. A short section by Dr. Feigl describes his methods of spot analysis for the identification of substances by reactions taking place on porous or non-porous bases.

The quantitative methods described are necessarily modified macro-methods on a small scale, and a microscope is generally unnecessary for their performance, though a micro-balance is essential. For the qualitative reactions, except Dr. Feigl's spot tests, a microscope is, in general, necessary. The methods described effect economies in material and, when familiarity in their practice has been achieved, in time also.

The book is well illustrated with diagrams, etc., and concludes with lists of necessary and desirable apparatus, and hints for making substitutes for some of the more expensive items. It should be of much use to many busy

chemists who desire readily available information on this rapidly developing and interesting branch of analysis.

HANDBOOK OF CHEMICAL MICROSCOPY. By Emile Monnin Chamot, B.S., Ph.D., and Clyde Walter Mason, A.B., Ph.D. Volume II. Chemical Methods and Inorganic Qualitative Analysis. Pp. ix + 411, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1931.) Price 22*s.* 6*d.*

This book is one of the few, written in English, which deal with qualitative micro-chemical inorganic analysis. This subject is of rapidly growing importance, and the methods and technique which are described are valuable adjuncts to ordinary macro-methods of analysis. In practical work instances frequently occur in which a minute fragment of a substance must be identified, and where the ordinary methods of analysis are inapplicable, and a knowledge of the micro-tests and technique which have been developed in recent years must now be considered an almost essential part of the equipment of an up-to-date analyst.

Vol. II of the handbook deals entirely with the chemical methods and reactions employed in qualitative inorganic micro-chemical work. Quantitative micro-methods are in most cases modified macro-methods on a small scale, and the use of a microscope is unnecessary, but the results of the tests described in this book depend, in the majority of cases, on the identification, under the microscope, of crystals, precipitates or other phenomena.

The first two chapters, comprising forty-nine pages, deal with manipulative methods, and the means adopted for applying reagents, and Chapters III to X inclusive, pp. 50 to 285, give methods for the detection of the metallic elements. The authors state that they have been guided more by the applicability of the tests to the analysis of complex mixtures and by the certainty of the results obtained than by sensitivity of reaction. Chapter XI, which comprises pp. 286 to 362, treats of the detection of anions, and Chapter XII with a few special reagents for cations. In the final chapter the procedure to be adopted in the qualitative micro-analysis of a substance of unknown composition is outlined and a scheme for the analysis of common non-ferrous alloys is included. A short appendix deals, amongst other matters, with the preparation of some special reagents.

The book is well illustrated with photo-micrographs of most of the common identifications, but the authors wisely

point out that these should be used with discretion and should not be allowed to take the place of the direct study of actual tests.

The volume can be recommended to those interested in the practice of inorganic analytical chemistry as a very useful guide to a branch of the subject which, from several aspects, merits close consideration.

Antiques: their Restoration and Preservation. By A. Lucas, O.B.E., F.I.C. Pp. 240, $7\frac{1}{2} \times 5$. Second Edition. (London: Edward Arnold & Co., 1932.) Price 8*s.* 6*d.*

This book is written by an author whose experience in the Department of Antiquities, Egypt, has well qualified him for the task. Since the first edition was published in 1924 he has gained much additional experience during his work of cleaning and preserving antique objects taken from the tomb of Tutankhamen and elsewhere, and the book has been thoroughly revised and brought up to date.

The subject-matter is divided into four chapters. The first two deal generally with the restoration and preservation of antique objects, while the third describes in considerable detail the application of the various methods to special materials. In the fourth chapter some simple physical and chemical tests are briefly explained.

Although the book will make its greatest appeal to archæologists, curators of museums and collectors, there is a good deal that is of interest to the layman. Methods for the cleaning and preservation of many materials, such as metals, pictures, leather and stone, cannot fail to be of general utility, and the clear and readable way in which the necessary technique is described should render the work of value to a wide circle of readers.

BOOKS RECEIVED FOR NOTICE

A Handbook of Nyasaland. Compiled by S. S. Murray. Pp. xxxviii + 436, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: The Crown Agents for the Colonies; Zomba: The Government Printer, 1932.) Price 5*s.*

College Geography. By Earl C. Case and Daniel R. Bergsmark. Pp. xiii + 700, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 28*s.*

THE H. E. A. YEAR BOOK. Volume I, 1932. Hon. Editor: R. T. Pearl, B.Sc., A.R.C.S., D.I.C. Pp. xl + 92, $9\frac{3}{4} \times 6\frac{1}{4}$. (Wye: The Horticultural Education Association, 1932.) Price 3*s*. 6*d*.

INTERNATIONAL INSTITUTE OF AGRICULTURE, ROME. BIBLIOGRAPHY OF TROPICAL AGRICULTURE, 1931. Pp. 70, $9\frac{3}{4} \times 6\frac{3}{4}$. (Rome: Treves, Treccani, Tumminelli, S. A., 1932.)

COCOA IN SÃO TOMÉ AND PRÍNCIPE. By Leonard J. Schwarz. U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 138. Pp. 27, 9 × 6. (Washington: Government Printing Office, 1932.) Price 5 cents.

LE COTON EN AFRIQUE TROPICALE. By Paul E. A. Janssens. Pp. 402, $9\frac{1}{2} \times 6\frac{1}{4}$. (Brussels: Ateliers R. Bausart, 1932.) Price 14 belgas, in Belgium 60 francs.

ON THE FIXATION OF ATMOSPHERIC NITROGEN BY BACTERIA LIVING SYMBIOTICALLY IN ROOT NODULES OF CASUARINA EQUISETIFOLIA. By R. N. Aldrich-Blake, M.A. Oxford Forestry Memoirs, Number 14, 1932. Pp. 20, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1932.) Price 3*s*. 6*d*.

FLOTATION PLANT PRACTICE. By Philip Rabone, A.R.S.M., D.I.C., Assoc.Inst.M.M. Pp. xi + 141, 9 × 6. (London: Mining Publications, Ltd., 1932.) Price 10*s*. 6*d*.

CHEMICAL ENCYCLOPÆDIA. By C. T. Kingzett, F.I.C., F.C.S. Pp. viii + 1014, 9 × 6. Fifth Edition. (London: Baillière, Tindall & Cox, 1932.) Price 40*s*.

CHEMICAL ANALYSIS BY X-RAYS AND ITS APPLICATIONS. By Georg von Hevesey. Pp. 333, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1932.) Price 18*s*.

A FRENCH-ENGLISH VOCABULARY IN GEOLOGY AND PHYSICAL GEOGRAPHY. By G. M. Davies, M.Sc., F.G.S. Pp. ix + 140, $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Thomas Murby & Co., 1932.) Price 6s.

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Scientific names and titles of books are printed in italics and authors' names in capitals